Humalyzer 2000

Service Manual

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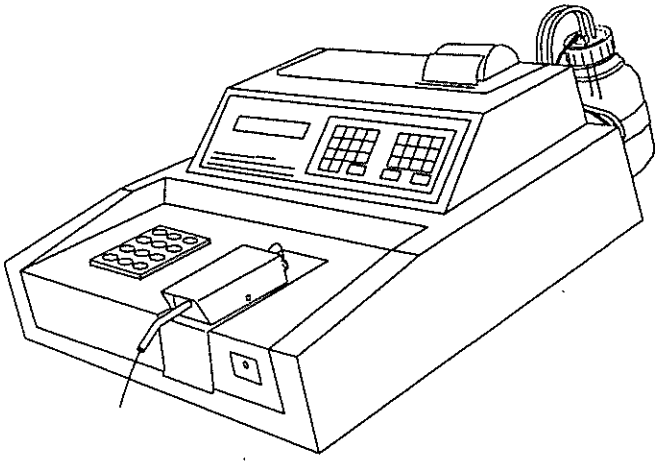


Rev. B 7/94

Introduction

The instrument is a general-purpose, bichromatic photometer system with six available wavelengths and 37°C incubation. Two additional wavelengths are optional, for a total of eight filters. A removable flowcell provides extremely rapid fluid sampling with low carryover. A built-in vacuum pump and an external autoclavable waste bottle with level sensing are supplied standard. When the flowcell is removed, the instrument accepts standard 12 mm round tubes as well as 1 cm square cuvettes. The instrument also contains an incubation block with 12 round tube stations. Both the incubation block and the read well are temperature controlled to 37°C.

Layout

Figure 1 shows the exterior of the instrument, Figure 2 shows the inside of the cover assembly, and Figure 3 shows the chassis layout. For clarity, some cabling arrangements are not shown.

The interface PCB mounted inside the cover behind the front panel, connects to the main PCB by a 26-conductor ribbon cable and header. A 2-conductor cable running from the main PCB to the interface PCB supplies separate power for the internal printer. The printer PCB connects to the interface PCB via a 14-conductor ribbon cable terminated with IDC 14-pin DIP plugs. The serial port connector (DB-9P) connects to the main PCB with a 4-conductor cable. The parallel port (DB-25S, IDC) connects to the interface PCB via a 26-conductor ribbon cable and header. Finally, a 4-conductor cable connects the ready/sample PCB to the interface PCB.

All AC mains (high voltage) circuitry is enclosed behind the AC cover. However, three 18 AWG wires feed 115VAC with ground to the incubation block heater PCB. Note that the block itself is tied directly to this ground.

WARNING

Hazardous line voltages are present behind the AC cover and beneath the incubation block. Always disconnect the external AC power cable before servicing the instrument.

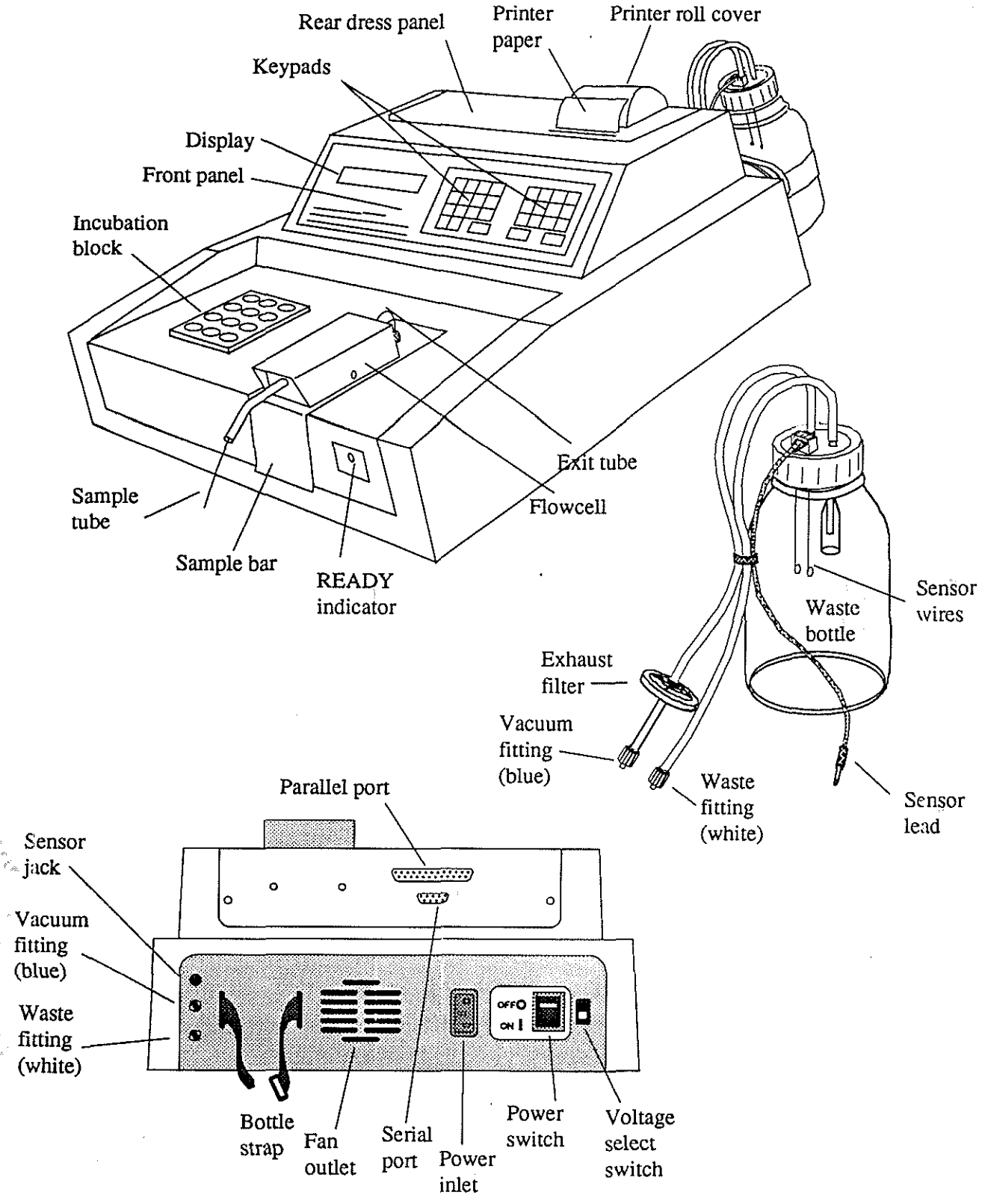


Figure 1. Instrument Exterior

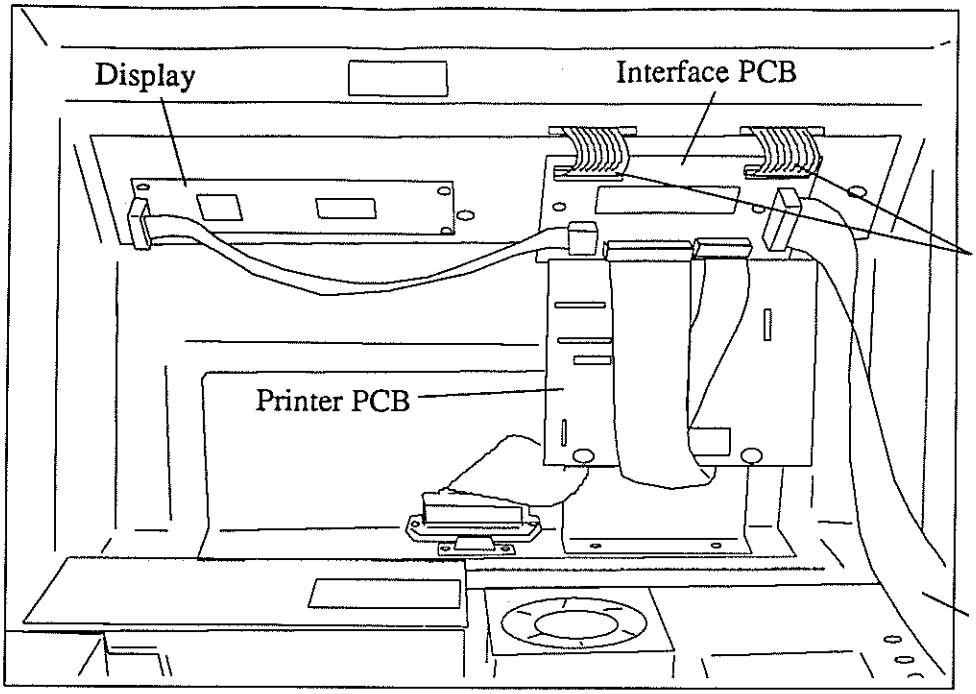


Figure 2. Inside the Cover

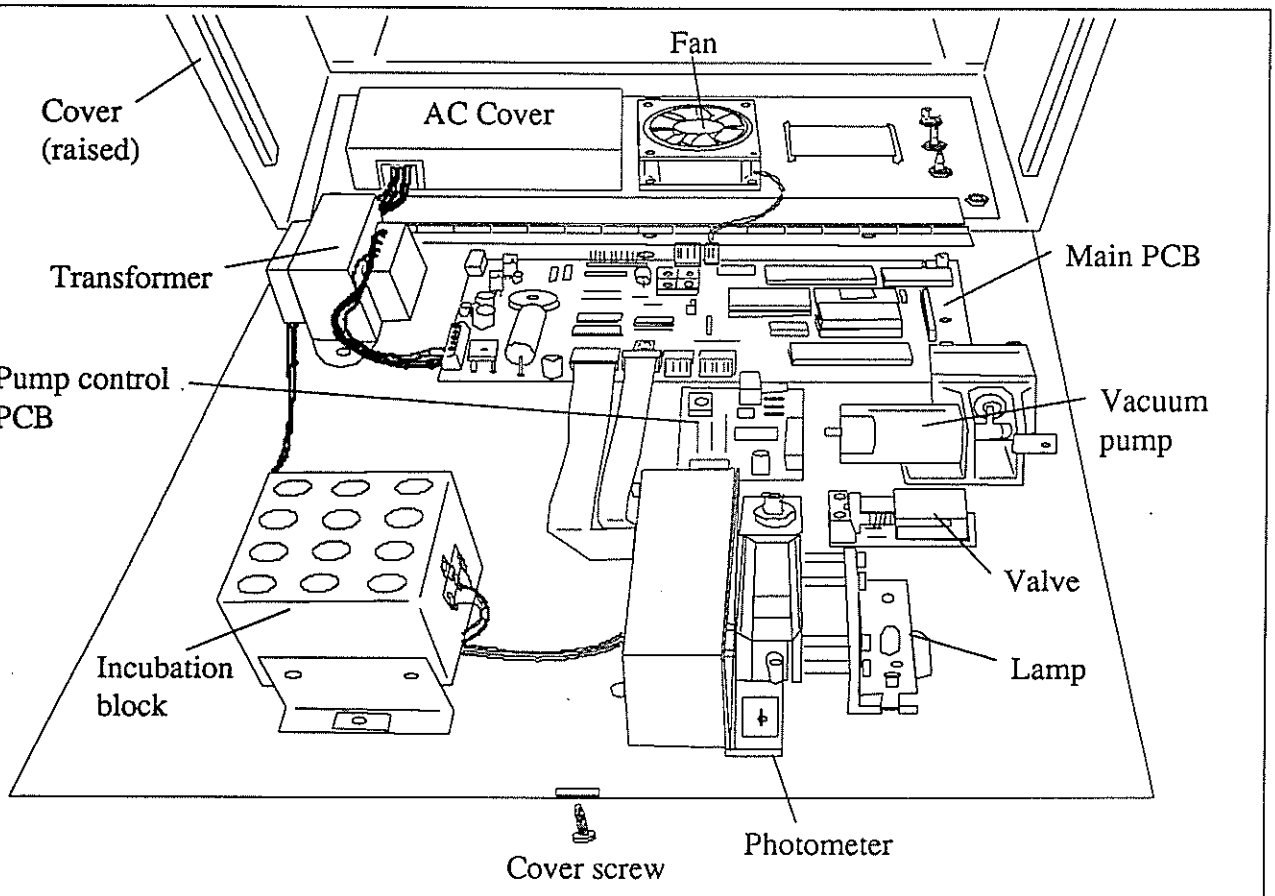


Figure 3. Chassis Layout

Principles of Operation

Photometer

The light from a tungsten-halogen lamp is passed horizontally though the tube or flowcell and the sample it contains. The sealed box on the opposite side of the read well contains a rotating filter wheel and photodiode. The filter wheel contains eight interference filters of various wavelengths, and is speed controlled to approximately 3 rps under software control. As each filter passes in front of the photodetector, an infrared optical switch triggers a sampling of the peak voltage produced by the photodetector. The voltage is then fed to a comparator which compares the sampled voltage to the output of an exponential capacitor decay circuit. The pulse at the output of the comparator enables a 16 bit counter in an 8254 programmable timer. The photodetector output is proportional to the intensity of the light, whereas the width of the positive phase of the comparator output is proportional to the absorbance. The resistance across the log cap (RC decay) determines the base of the log (10 for absorbance) and is used to adjust the low-end absorbance calibration (gain). Another potentiometer is used to adjust the high-end absorbance (offset).

Temperature control

The incubation block and read well are maintained at 37°C by means of thermistors (10k @25°C). These thermistors are multiplexed at 0.5 second rate into the feedback path of oscillator U14A. The waveform at U14A is a sawtooth of approximately 1.2 Vpp amplitude centered at +2.5 V. Schmitt triggers U11 convert this to a square wave for current reversal and to drive the CLK2 input of U4. The microprocessor heats the system to maintain the frequency of this signal at 2.08 kHz, the 37°C set point.

Power resistors located on the bottom of the incubation block are switched to 115VAC via an opto-triac. A red LED located on the block PCB illuminates when heat is on. A similar system is employed for the read well except that driver U10 applies 12VDC (raw) across heater resistors located on the cell PCB.

Flowcell and Vacuum Pump

An integral DC vacuum pump maintains a constant vacuum on an external waste bottle, by means of a solid-state vacuum sensor circuit on the pump control PCB . A solenoid-operated pinch valve is opened for a precise interval under microprocessor control, to apply this vacuum to the flowcell. Sample (or air) is drawn through the flowcell and into the waste bottle. Sensor wires built into the bottle cap are used in conjunction with a detector circuit on the pump control PCB to indicate a full condition on the waste bottle.

Display, Keypad, and Thermal Printer

A 24 x 2 line character Liquid Crystal Display (LCD) is mounted inside the cover. Two 4 x 4 membrane switch keypads are sealed behind the front panel overlay. The LCD connects to the interface PCB via a 14-pin DIP cable. The tails of the keypad switch layers are fed through the cover and are connected to the interface PCB. The printer assembly, consisting of a 20-column

thermal printer, the printer PCB, and metal supports, is mounted to the rear dress panel and is connected to the interface PCB via a 14-pin DIP cable.

System Control

The instrument is based on the 8 bit Z80 microprocessor. The software is permanently stored in a 27256 EPROM. A battery-backed non-volatile RAM (random access memory) chip (MK48T08) incorporating a real-time clock is used store data such as calibration, test setups, samples, and also maintains the date and time. A static RAM chip (6264) is used for temporary storage. Almost all digital I/O is accomplished with an 8255 Programmable Peripheral Interface. Time intervals and pulse widths are measured using the counter channels of an 8254 programmable timer.

Troubleshooting

The instrument incorporates solid-state electronics in a very reliable field-proven design. In this section, each subassembly or component group is discussed, possible problems and solutions are outlined.

Power Supply

The power supply consists of a transformer, two diode bridges, and three regulators. Line voltage supplied to the transformer is converted to 36 VAC, center tapped, which feeds diode bridge BR2. The center tap is used as a reference for regulators VR4 and VR5, which provide +15 VDC and -15 VDC for analog circuitry. Another transformer output supplies 11VAC to diode bridge BR1, which provides +12VDC (raw, 11-13 VDC nominal) to the system, and VR3 regulates this down to +5VDC for the logic and other low voltage control circuits.

A "dead" instrument may be just a blown fuse. However, a blown fuse may indicate a problem on the main PCB or transformer. Also, the voltage select switch setting must match the line voltage. If there is no voltage present at J6, check the fuse. To replace the fuse, disconnect the power cable and open the instrument. Remove the two #4 screws holding the AC cover to the rear panel and lift the AC cover off towards the front of the instrument. Locate the double clip fuse holder mounted on the inside of the rear panel. Locate the blown fuse and remove it with a fuse puller, or carefully pry it out with a small screwdriver. Install a 0.6A 3AG slow blow fuse. Use only the recommended fuse. Do not substitute other rating! Replace the AC cover.

If voltage is present at J6, check for input voltage on VR3, VR4, and VR5. If no voltage is present, the diode bridge BR1 or BR2 may have failed.

Photometer

The photometer assembly can be examined as several component systems:

- Read well assembly and cell heat PCB
- Lamp and brackets
- Photometer PCB
- Filter wheel and motor.

The read well assembly serves to hold the tube or flowcell centered on the cell block, between a fixed plate and a spring loaded plate. Mechanical adjustments are not required. The presence of a tube or flowcell is detected by an opto pair (phototransistor and IR LED) mounted at the ends of the cell heat PCB. A stainless steel plunger in the bottom center of the cell block forces a small spring plate into the light path between the opto pair.

The lamp is tungsten-halogen, rated at 6V, 10W, and is intended to be maintenance free for the life of the instrument, since the lamp is turned off automatically after 30 minutes of instrument inactivity. However, under heavy usage the lamp remains on for longer periods and may require replacement as the output becomes low near the end of its service life. In addition, a physical shock to the instrument may necessitate lamp replacement due to filament breakage. The lamp and lens brackets simply hold the lamp and lens in alignment with the rest of the assembly. The

brackets provide adjustments in both horizontal and vertical dimensions, so that the filament can be centered on the light path. The lamp must be replaced if output becomes low or the lamp fails completely. To check for low lamp output, run test #186. Press **MENU**, then type 186 and press **ENTER**. The instrument prints the detected voltage for each filter. The printout shows the wavelength, position, and the voltage for each filter. The voltages should be between 2 and 10 volts. If all or most of the voltages are low, the lamp is the likely suspect. As a final check, measure the voltage at the lamp terminals. If the lamp voltage is much lower than 4.5 VDC, the regulator circuitry on the main PCB (Q6 and VR1) may be the problem. Otherwise, replace the lamp. Refer to the section "Lamp Replacement".

The photometer PCB contains a photodiode, a very sensitive op amp circuit and phototransistors. Because the photodetector and related circuitry is solid-state, it should require no service. Do not attempt to modify the photometer PCB.

The filter wheel turns on a shoulder screw shaft and is driven by the filter wheel motor via a neoprene belt. The filter wheel itself requires no adjustments. The optical interference filters contained in the wheel are of metal deposition type construction and are intended to be maintenance free for the life of the instrument. However, in a non-ideal environment where extreme humidity or temperature are encountered, optical characteristics on one or more filters may be compromised. Run test # 186 as described above. If only one or two filter voltages are low, the filter(s) may be suspect. Refer to the service procedure "Filter Replacement".

Flowcell

If proper care is taken to clean the flowcell between uses, especially after highly proteinaceous liquids have been sampled, the flowcell itself should require little or no maintenance.
The flowcell should be cleaned regularly as described in "Cleaning the Flowcell". If the flowcell tubing has become damaged or the flowcell is clogged, the flowcell can be disassembled for cleaning and parts replacement. Refer to the service procedures "Flowcell Tubing Replacement" and "Flowcell Disassembly".

Erratic readings (excessive dither) may be a result of trapped air in the flowcell. This can be caused by improper installation of, or failure of the flowcell tubing or coupling tubes. See the section "Flowcell Tubing Replacement". Check the insertion depth of the flowcell tubes into the coupling tubes. Ensure that a leak-free seal is made and that no tubes are kinked or pinched off.

Valve

The valve uses a short length of silicone tubing. If the valve operates but no sample is drawn up, the pinch valve tubing may be blocked. To check for clogged valve tubing, unscrew the flowcell vacuum line from the Luer fitting. Press PURGE and listen for aspiration. If you hear aspiration, the valve is operating, but the flowcell is clogged. If you do not hear aspiration, the valve tubing is clogged. See the section "Valve Tubing Replacement".

Vacuum Pump and Pump Control PCB

The vacuum pump and pump control PCB should require no maintenance. If the vacuum pump runs continuously, you probably have a leak in the vacuum side. Check the waste bottle cap and fittings. Check that the tubing is firmly seated on barbs and all fittings are tight. Turn the fittings only until finger-tight. Do not over-tighten the plastic Luer fittings! If the waste bottle is located at a higher or lower level than the instrument, such as on a shelf, or if the instrument is used at very high altitudes, the vacuum trimpot may require adjustment. See the section "Vacuum Adjustment". If the vacuum pump is taking longer to achieve full vacuum (runs much longer than usual, but otherwise works), the exhaust filter is likely clogged and should be replaced. In the event that the exhaust filter gets wet due to a waste bottle spill, it must be replaced. See the section "Exhaust Filter Replacement".

Temperature Control

The temperature control system is very stable and ordinarily does not require adjustment or recalibration. In the event calibration must be verified or re-established, refer to the section "Temperature Calibration".

Main PCB

Under normal circumstances, there are no adjustments to be made to the main PCB. Circuit failures are highly unlikely, but if they occur, it is recommended that the repairs be performed by factory authorized technicians. There are ten test points on J8 which provide access to a number of vital signals. The instrument can be observed in operation with an oscilloscope. Typical test point waveforms are shown in Figure 4.

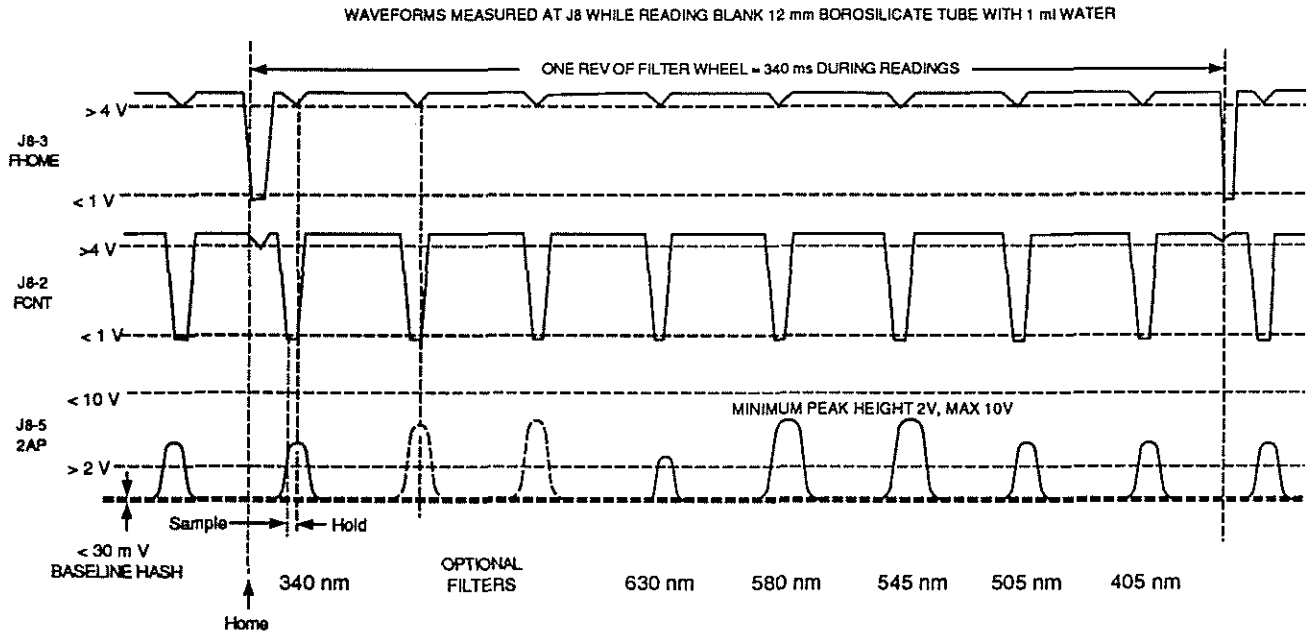


Figure 4. Test point waveforms

Internal Printer

The internal printer is a 20-column thermal type device which prints ASCII characters using a 5 x 7 dot matrix. There are no adjustments. However, a printer jam can occur if the printer paper tears and becomes lodged in the printer mechanism, thus preventing the print head from moving freely. If the instrument displays "Printer is jammed!", or if the print head does not return to the home position, check for obstructions in the print head path..

CAUTION

Do not apply any force to the white ceramic print head! Do not scratch the platen or pry with sharp objects. This will destroy the printer!

Carefully remove any paper or debris with a pair of tweezers. Turn off the power switch, wait 5 seconds, then turn on the power switch. The print head should move to the right side and then return to home position at the left.

An alternate method of removing a particularly stubborn wad of paper is to move the print head manually. To do this, remove the rear dress panel. Look at the front of the printer mechanism. Locate the small gear on the right side which turns the grooved steel print head shaft. Turn the gear so that the print head moves away from paper wad and the paper can be easily removed. Turn the power switch off and back on again as described above.

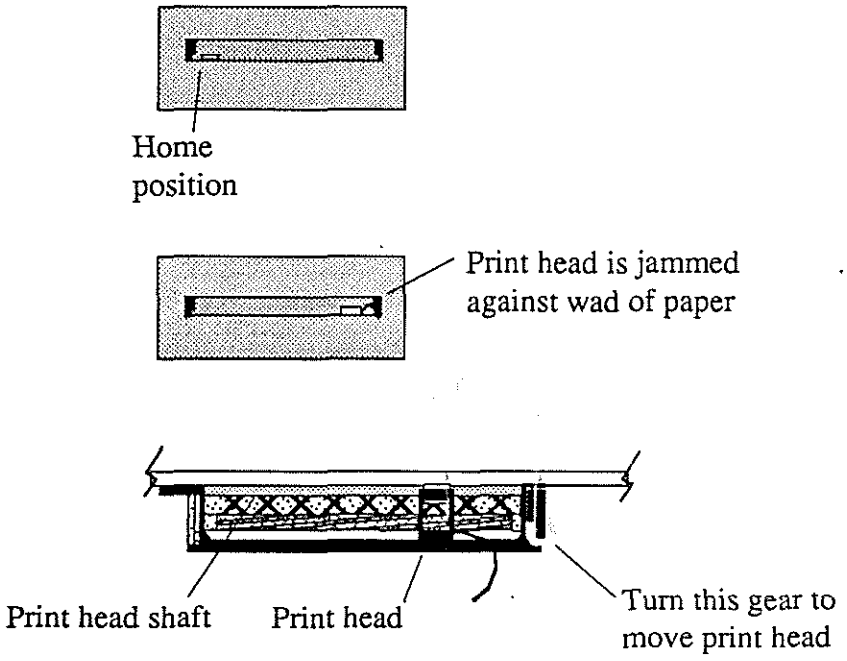


Figure 5. Clearing printer jams

Keypad

The keypad is a sealed membrane switch layer which is not serviceable. You can test the keypad by pressing **AUX**, then pressing all keys except **CLEAR** and **ENTER**. Note that each key causes the instrument to beep and display a character. Press **CLEAR** and the display clears. Press **ENTER** to end the test.

Display

The display is a 24 x 2 line super twisted nematic liquid crystal display module with integral controller. The display should be clearly legible at all times, with no dark spots or stray dots. There are no adjustments.

Serial Port

By using a special cable, a serial printer or computer with a serial port may be connected. This is a male 9-pin DB-style connector using RS-232 signals in a non-standard pinout. The data format is 2400 baud, 8 bits, 1 stop bit, and no parity.

The pinout for the serial port is:

1	GND
2	TX
3	RX/DTR
4-9	NC

Contact your distributor to obtain a serial printer cable.

Error Messages

Error messages are displayed when the instrument fails to operate correctly. They are intended to help the operator locate the problem. If error messages appear frequently, a hardware problem is usually indicated.

The following error messages indicate possible interface or component problems.

Lamp Failure	The lamp does not appear to illuminated at all. Low voltages were detected for all filter positions. See the section "Photometer" under "Troubleshooting".
Lamp Output Low	The lamp does not appear to be illuminated sufficiently. Low voltages were detected for some filter positions. This is possibly due to degraded filters. See the section "Photometer" under "Troubleshooting".
Printer Paper Jam	The internal printer paper path is obstructed. Clear the paper path. If the paper path is clear, Check the 14-pin DIP cable connecting the printer PCB to the interface PCB.
Printer Not Ready	The external printer attached to the parallel port or serial port is out of paper or otherwise unable to print. If chronic, this may indicate an incorrectly wired external cable.
Waste is Full ! XX	The waste material has reached the level sensors. If the waste bottle is empty, check the sensor cable, jack, and internal wiring for shorts. On the pump control PCB, check U2A, Q2 and U3. Check the cable from the pump control PCB to the main PCB.
Empty Waste-Press Enter	See "Waste is Full !", above.
Filter Wheel Err	The instrument cannot correctly detect pulses from the filter wheel. Check the photometer LED board and the phototransistors Q12 and Q13 on the photometer PCB. See the section "Photometer" under "Troubleshooting".
Vacuum Leak	The self-check routine was unable to achieve vacuum within the prescribed length of time. Check for leaks at the waste bottle and at all connections.

The following error messages indicate possible failure of the NV RAM U3, or the address decoding logic at U6,U7, and U16. U3 can be checked by substitution.

Memory Error	The checksum failed when a stored test was recalled. The test was deleted.
Filter Labels 7&8 Clrd	The stored filter labels were corrupted or not found. See the section "Restore Filter Labels".
Water Values Reset	The stored water absorbances were corrupted or not found.
Do Temp Test 210!	The stored temperature calibration values were corrupted or not found. See the section "Restore Calibration".
Do ABS Test 212!	The stored absorbance calibration values were corrupted or not found. See the section "Restore Calibration".

Service Procedures

Opening the Instrument

Refer to Figure 3., Instrument Interior. The cover is hinged at the rear panel, and can be raised to allow access to the inside of the instrument. Disconnect the power cable, the tubing, and the sensor lead from the rear panel. Move the instrument forward until the front edge overhangs the work surface. Locate and remove the cover screw from the underside of the front edge. Gently lift the front of the cover upward, taking care to clear the incubation block and photometer. Prop the cover open with a suitable object.

Do not force the cover backwards. Damage to the cover or fittings may result.

To reinstall the cover, reverse the procedure. Carefully lower the cover until it seats on the chassis, taking care to clear the incubation block and the Luer fitting. Replace the screw.

Cleaning the Flowcell

The flowcell should be cleaned when the instrument will not be used for an extended period, e.g. overnight, end of shift, and when storing the flowcell. Proper cleaning will help to prevent clogging of the flowcell tubing and valve tubing. Cleaning is extremely important to obtaining accurate, repeatable results. If reagent, serum, or other proteinaceous fluid is allowed to dry in the flowcell, it is extremely difficult to remove and its presence can affect test results.

To clean the flowcell:

1. Purge with air for at least 5 seconds.
2. Aspirate several ml of flowcell cleaning solution. Allow the solution to remain in the flowcell for 3 minutes.
3. Aspirate 15 ml of distilled water then purge with air for 5 seconds.
4. Aspirate 0.1N sodium hydroxide (NaOH). Allow the solution to remain in the flowcell for 3 minutes.
5. Purge with air for at least 5 seconds.
6. Aspirate 0.1N hydrochloric acid (HCl). Allow the solution to remain in the flowcell for 3 minutes.
7. Purge with at least 15 ml of deionized water.
8. If the flowcell is to be removed for storage,, purge with air until no more fluid can be seen flowing into the waste bottle. Otherwise, leave the flowcell filled with water.

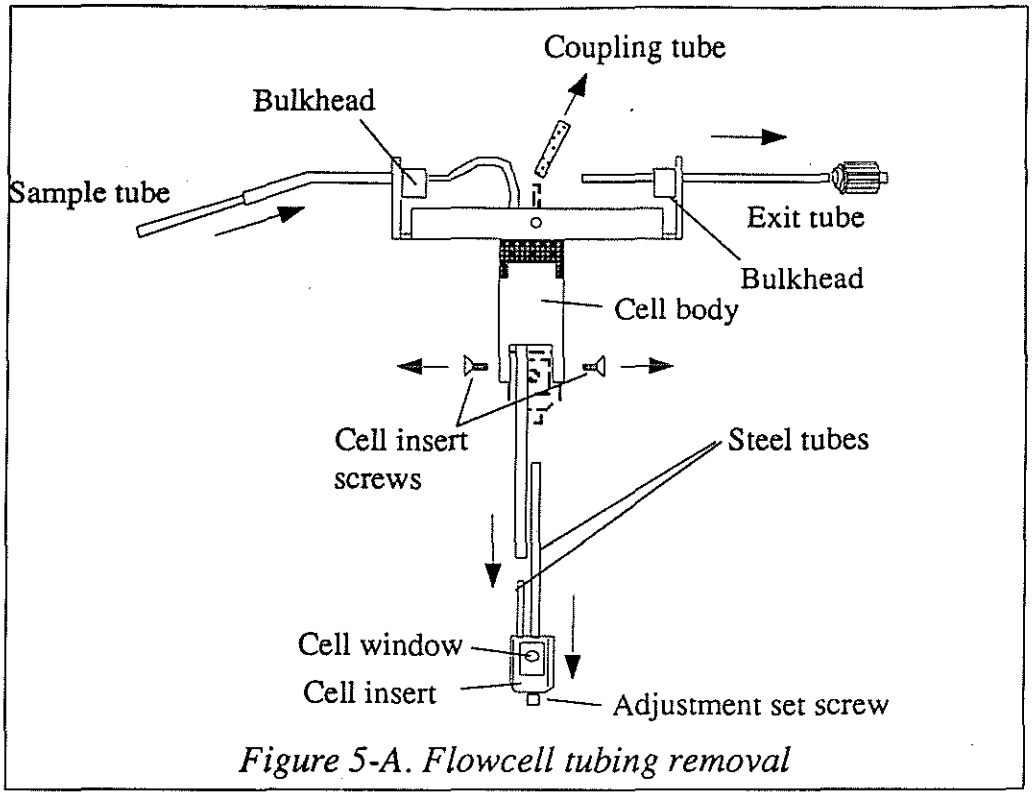


Figure 5-A. Flowcell tubing removal

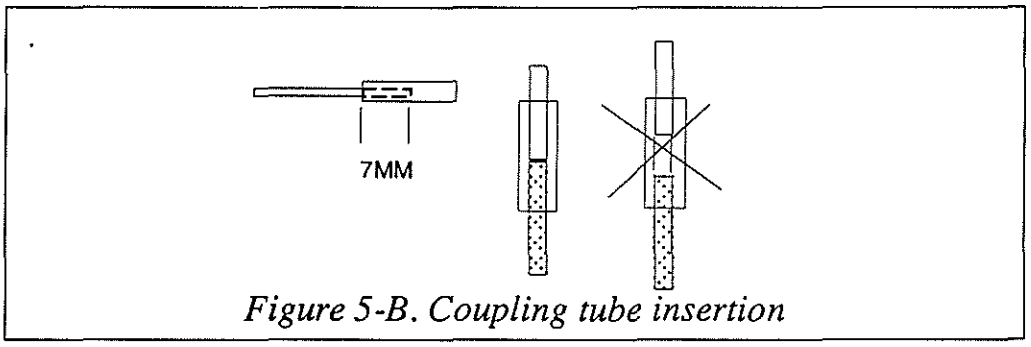


Figure 5-B. Coupling tube insertion

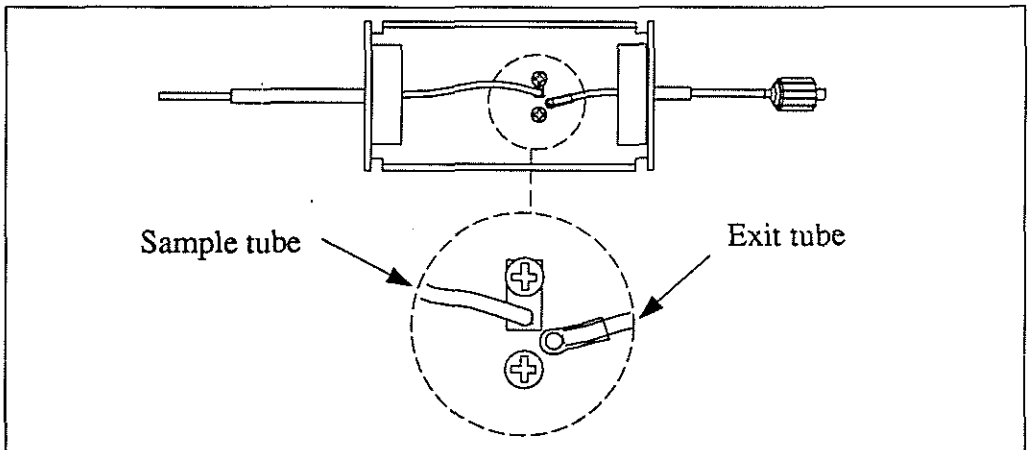


Figure 5-C. Tubing orientation

Flowcell Tubing Replacement

The flowcell utilizes 1.2 mm I.D. Teflon tubing for the sample and exit tubes. Replacement tubing is included with the tubing kit. Follow this procedure to replace the flowcell tubing.

1. Remove the flowcell. Unscrew the Luer and lift the flowcell out of the read well.
2. Remove the cover screws and lift off the upper flowcell cover.
3. Refer to Figure 5-A. Disconnect the coupling tube from the steel tube, then remove the coupling tube from the exit tube. Pull the exit tubes out through the bulkhead. Remove the cell insert screws and pull the cell insert and the sample tube out. Remove the sample tube from the steel tube.
4. Select the long or the short sample tube. The short sample tube must be used when the sample volume is set to 350 µl or less. Carefully press fit the end of the sample tube with the red dot (swaged end) to the steel tube on the cell insert, and feed the other end upward through the cell body. Hint: grasp the tubing with a small piece of #400 grit emery paper. Do not kink the tubing. Refer to Figure 5-C for the proper orientation. Do not reverse the orientation as improper sampling will result. Install the cell body and screws.
5. Feed the exit tube in through the rear of the flowcell.Press a new coupling tube over the end of the exit tube. The exit tube must be inserted at least 7 mm to ensure a leak-free seal. Minimize the gap between the ends of the tubes as shown in Figure 5-B.
6. Press the coupling tube (exit tube) over the corresponding steel tube.

Flowcell Adjustment

The flowcell must be adjusted after replacing the flowcell tubing, or any time the cell insert is removed or the adjustment set screw is disturbed.

1. With the instrument on, lift the flowcell out of the read well. Do not unscrew the fitting.
2. Press **MENU**. Type 189 and press **ENTER**. The instrument will continuously report the detector voltage at 405 nm. Record this value for reference in the next step.
3. Sample deionized water. Visually confirm there are no air bubbles in the cell window.
4. Insert the flowcell into the read well until it bottoms out. Note the value displayed. If the displayed value is more than 50% greater than the value you recorded in step 2, no adjustment is needed.
5. If the displayed value is less than 50% greater than the value in step 2, Remove the flowcell. Adjust the set screw with the hex wrench supplied. Turn the set screw 1/4 turn in either direction and go to step 4. If the value in step 4 increases, turn the set screw in the same direction. If it decreases, turn the setscrew in the opposite direction.
6. Repeat steps 4 and 5 until the displayed value is at a maximum.
7. When complete, press **CLEAR** twice to return to the main prompt. You must read new water values as described in "Flowcell Configuration".

Flowcell Tubing Replacement

The flowcell utilizes 1.2 mm I.D. Teflon tubing for the sample and exit tubes. Replacement tubing is included with the tubing kit. Follow this procedure to replace the flowcell tubing.

1. Remove the flowcell. Unscrew the Luer and lift the flowcell out of the read well.
2. Remove the cover screws and lift off the upper flowcell cover.
3. Refer to Figure 5-A. Disconnect the coupling tube from the steel tube, then remove the coupling tube from the exit tube. Pull the exit tubes out through the bulkhead. Remove the cell insert screws and pull the cell insert and the sample tube out. Remove the sample tube from the steel tube.
4. Select the long or the short sample tube. The short sample tube must be used when the sample volume is set to 350 µl or less. Carefully press fit the end of the sample tube with the red dot (swaged end) to the steel tube on the cell insert, and feed the other end upward through the cell body. Hint: grasp the tubing with a small piece of #400 grit emery paper. Do not kink the tubing. Refer to Figure 5-C for the proper orientation. Do not reverse the orientation as improper sampling will result. Install the cell body and screws.
5. Feed the exit tube in through the rear of the flowcell.Press a new coupling tube over the end of the exit tube. The exit tube must be inserted at least 7 mm to ensure a leak-free seal. Minimize the gap between the ends of the tubes as shown in Figure 5-B.
6. Press the coupling tube (exit tube) over the corresponding steel tube.

Flowcell Adjustment

The flowcell must be adjusted after replacing the flowcell tubing, or any time the cell insert is removed or the adjustment set screw is disturbed.

1. With the instrument on, lift the flowcell out of the read well. Do not unscrew the fitting.
2. Press **MENU**. Type 189 and press **ENTER**. The instrument will continuously report the detector voltage at 405 nm. Record this value for reference in the next step.
3. Sample deionized water. Visually confirm there are no air bubbles in the cell window.
4. Insert the flowcell into the read well until it bottoms out. Note the value displayed. If the displayed value is more than 50% greater than the value you recorded in step 2, no adjustment is needed.
5. If the displayed value is less than 50% greater than the value in step 2, Remove the flowcell. Adjust the set screw with the hex wrench supplied. Turn the set screw 1/4 turn in either direction and go to step 4. If the value in step 4 increases, turn the set screw in the same direction. If it decreases, turn the setscrew in the opposite direction.
6. Repeat steps 4 and 5 until the displayed value is at a maximum.
7. When complete, press **CLEAR** twice to return to the main prompt. You must read new water values as described in "Flowcell Configuration".

Flowcell Disassembly

The flowcell may be disassembled for extensive cleaning or replacement of the cell insert.

To replace the cell insert:

1. Follow the procedure for Flowcell Tubing Replacement except install a new cell insert before beginning step 6.

2. Install the new cell insert in the same orientation as the old. Do not force the new cell insert into the lower cell body. The part should slide easily into place. If it does not fit easily, rotate the part 180°.

3. Install the (2) #2-56 screws that attach the flowcell insert to the lower cell body.

4. Complete the procedure "Flowcell adjustment" to restore optical alignment.

To completely disassemble the flowcell:

1. Follow the procedure for Flowcell Tubing Replacement through step 3.

2. Remove (2) #2-56 screws holding the lower cell body and lift it off.

3. Remove (2) #4-40 screws holding the upper cell body and separate it from the cell bracket.

4. Assembly is the reverse of this procedure. After assembly, complete the procedure "Flowcell adjustment" to restore optical alignment.

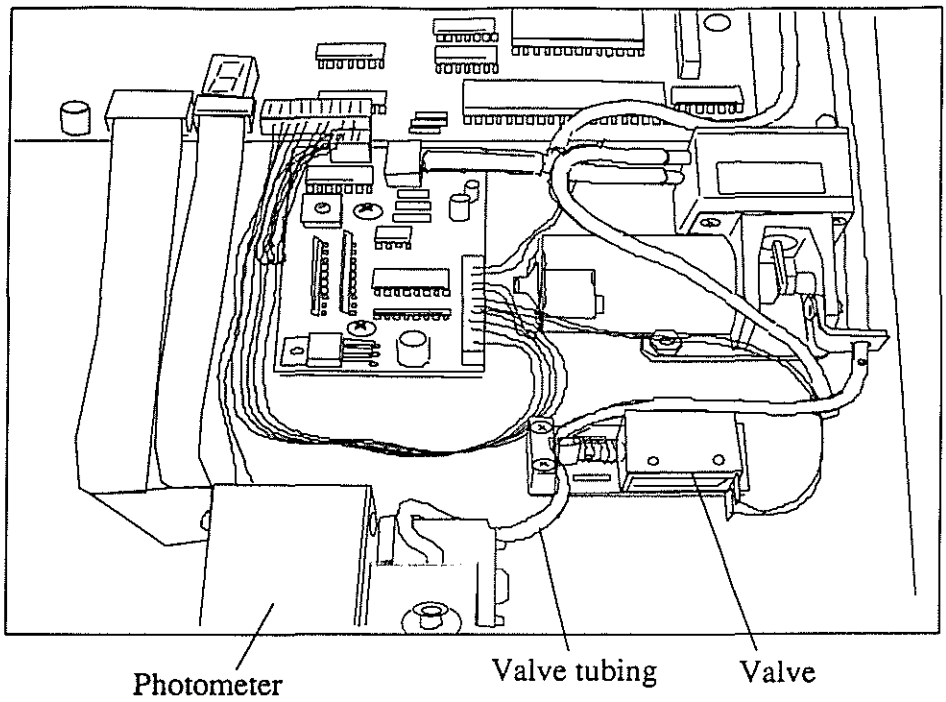


Figure 8-A. Valve location

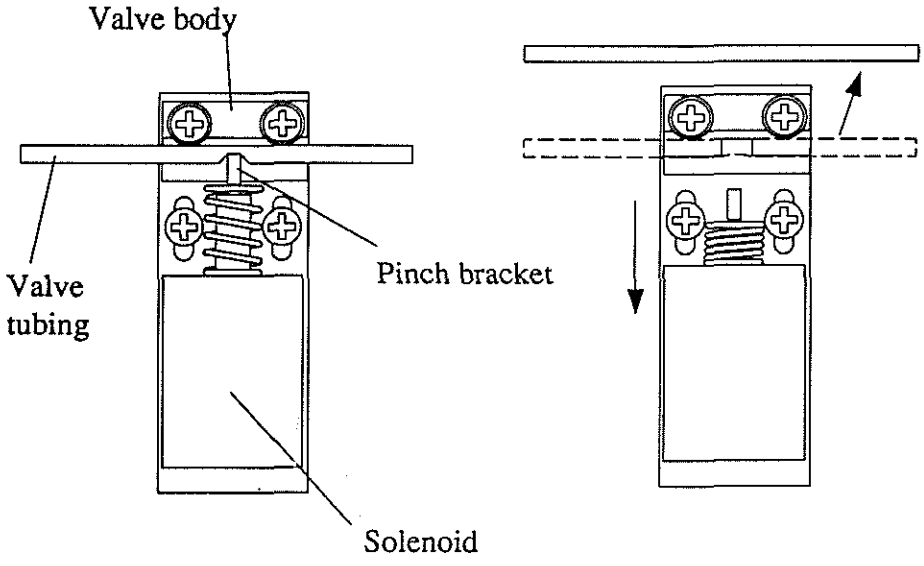


Figure 8-B. Valve Tubing Replacement

Valve Tubing Replacement

The short length of silicone tubing used in the sampling valve may become clogged or worn with age. A replacement is included in the tubing kit.

1. Set the power switch to OFF (O). Open the instrument as described in "Opening the instrument" . Refer to Figure 8-A. Locate the valve behind and to the right of the photometer.

2. Refer to Figure 8-B. Pull back the pinch bracket and remove the valve tubing from the valve body.

3. Disconnect the valve tubing from the fittings at both ends.

4. Install the replacement tubing to the valve body in a similar manner. Push the tubing over the tubing barbs until seated. Be especially careful not to kink, stretch, or tension the tubing.

5. Carefully lower the instrument cover and replace the screw.

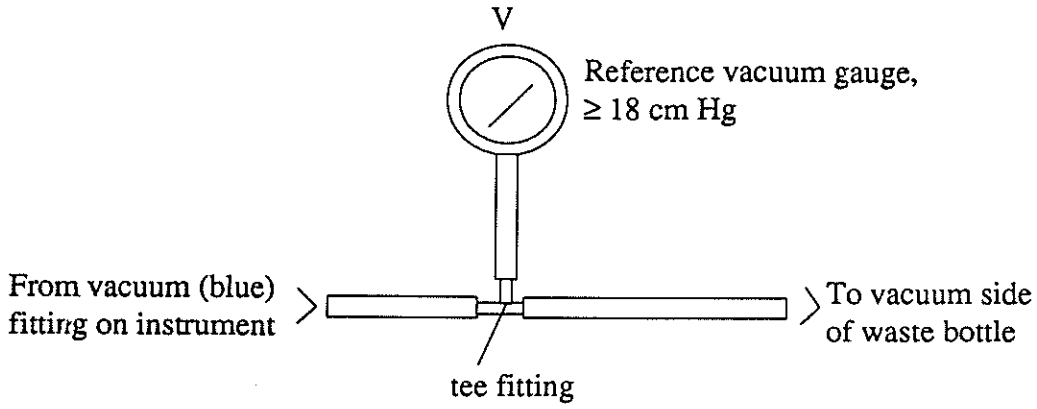


Figure 9-A. Gauge connection

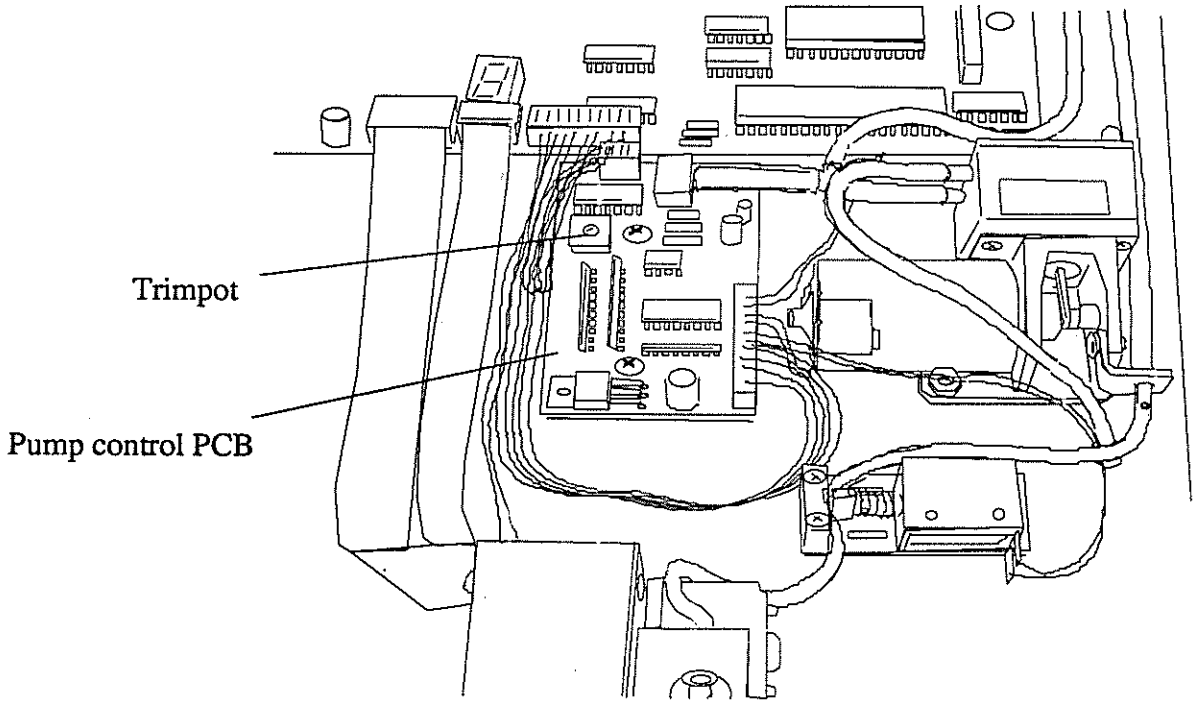


Figure 9-B. Vacuum adjustment

Vacuum Adjustment

To adjust the vacuum, you will need:

Reference vacuum gauge reading at least 18 cm Hg.
(2) 15 cm length of 3.1 mm ID flexible tubing
3.1 mm barbed "tee" fitting

1. Disconnect the vacuum line (blue Luer fitting) at the rear panel. Open the instrument.

2. Refer to Figure 9-A. Connect the vacuum gauge as shown. Refer to Figure 9-B. Locate the pump control PCB. Turn the trimpot on the pump control PCB fully counterclockwise.

3. Turn on the instrument. Press **PURGE** and wait until the vacuum pump stops running. The vacuum gauge should read much less than 18 cm Hg. Slowly turn the trimpot clockwise until gauge reaches 17.8 cm Hg. When turning the trimpot, pause while the pump runs to maintain vacuum.

4. Set the power switch to OFF (O). Disconnect gauge and tubing. Reconnect the waste bottle.

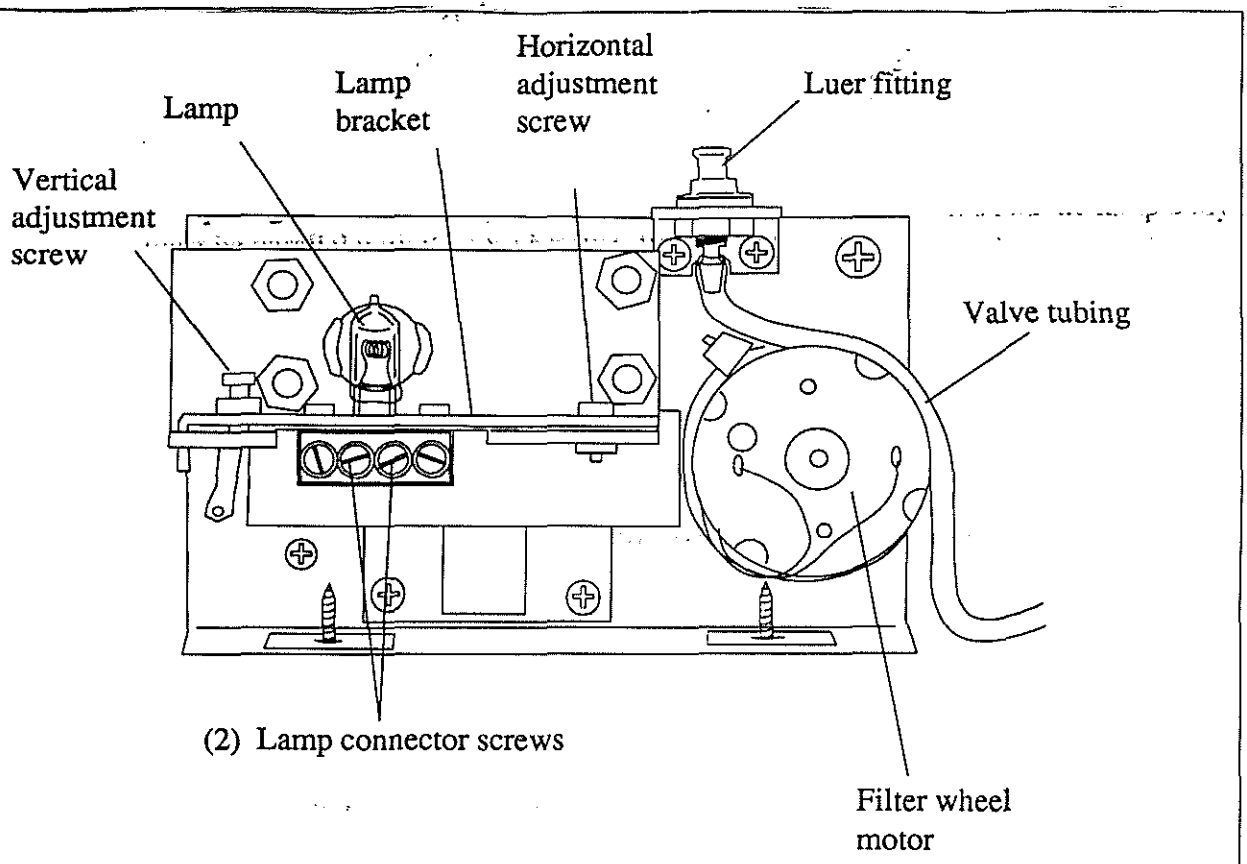


Figure 10-A. Lamp Removal and Adjustments

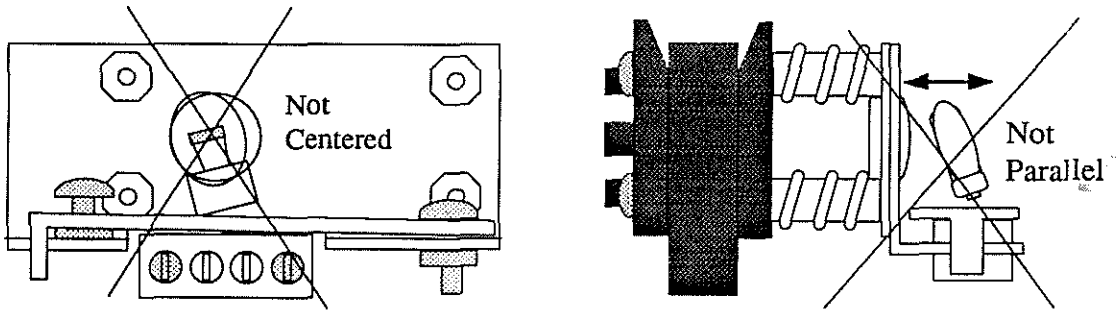


Figure 10-B. Lamp Alignment

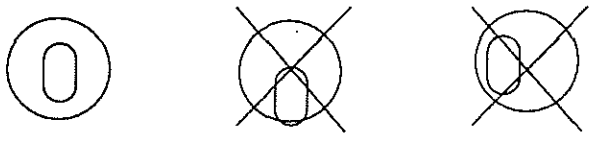


Figure 10-C. Spot Alignment

Lamp replacement

The lamp should be replaced only if it fails to light, or several filter voltages are reported as low.

To replace the lamp:

1. Place the instrument in tube mode. Press **CELL**. The display shows:

```
Flowcell Settings
Flowcell Active  Y/N
```

Press **NO** to select tube mode. Repeatedly press **NO** until the display shows

```
Ready. Select a Test.
Block: 37.0  Cell: 37.0
```

2. Set the power switch to OFF (O). Open the instrument. Locate the photometer and the lamp at the right side of the photometer. Refer to Figure 10-A, Lamp Removal and Replacement. The figure shows the right side view of the photometer assembly.

CAUTION

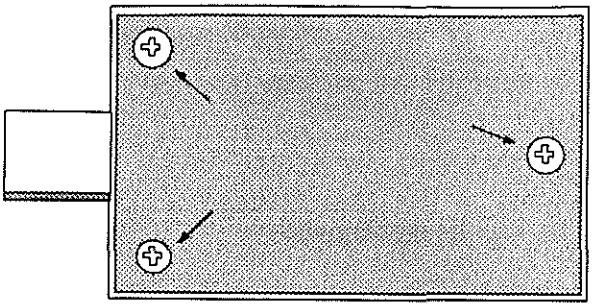
Lamp is HOT. Allow the lamp to cool before handling.

3. Loosen but do not remove the 2 center lamp connector screws. Remove the lamp by lifting it out of the connector.

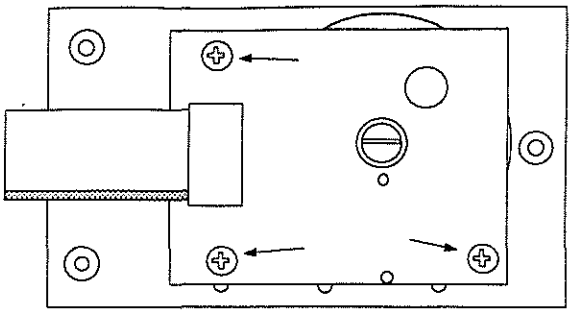
4. Use a pair of pliers or tweezers to handle the new lamp. Avoid handling with bare skin. Insert the lamp leads into the connector until they hit bottom. Refer to Figure 10-B, Lamp Alignment. The lamp filament must be centered on the lens and the lamp body must be parallel with the lens bracket. While holding the lamp in alignment, tighten the lamp connector screws.

5. Set the power switch to ON. Observe the projection of the light from the lamp onto the cell holder (behind the lens). Refer to Figure 10-C, Spot Alignment. The spot should be small and centered on the oval hole behind the lamp. If the spot is not centered, use the adjustment screws to position the spot. The vertical adjustment screw raises and lowers the lamp. The lamp bracket is slotted at the horizontal adjustment screw, so that the lamp bracket can be moved. The horizontal adjustment screw serves to lock down the lamp bracket.

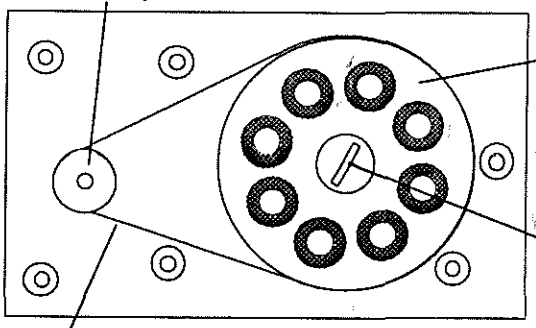
6. Insert a borosilicate 12 mm tube filled with plain water into the read well. Do not use a soda-lime glass tube, since it does not transmit at 340 nm. Press **MENU**. Type 186 and press **ENTER**. The instrument prints the detected voltage for each filter position. All voltages should be between 2.00 volts and 11.00 volts. If all the voltages report low, repeat steps 5 and 6.



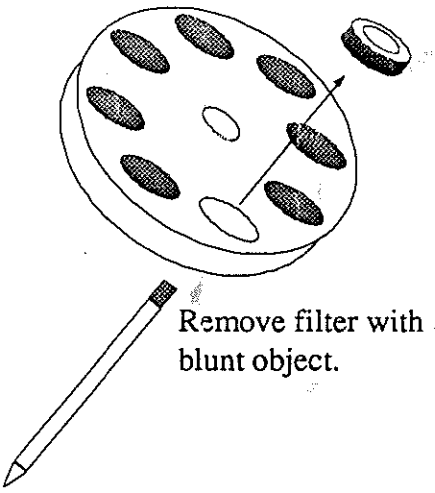
Remove screws holding photometer cover.



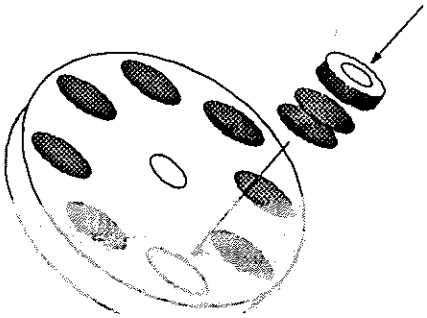
Remove screws holding photometer PCB.

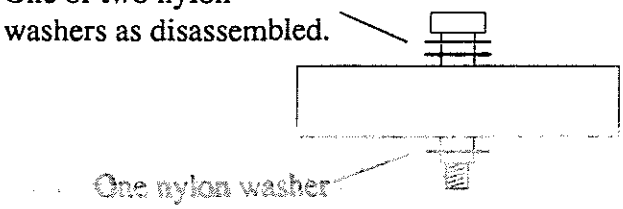


Remove filter wheel belt and filter wheel.



Remove filter with blunt object.





Filter Replacement

Materials/tools required:

- Replacement filter set
- Phillips screw driver
- Flat blade screw driver
- Silicone adhesive

1. Open the instrument as described in "Opening the instrument". Refer to Figure 3. Locate the photometer. Unplug both ribbon cables from the main PCB.

2. **This is an important step for relocating upon reassembly.** Mark with a pencil onto the chassis along the front and side edges of the photometer subassembly.

3. Locate the (3) #6 screws holding the photometer assembly to the chassis. From the bottom of the instrument, remove these screws and washer.

4. Refer to Figure 11. Remove the (3) 6-32 screws retaining the photometer cover. Set the photometer cover aside.

5. Remove the (3) 4-40 screws securing the photometer PCB and gently move it aside.

6. Remove the filter wheel belt from the filter wheel and motor pulley. Loosen the filter wheel shaft. Remove the shaft and filter wheel. Note the number of nylon washers and the order of installation.

7. Refer to Figure 12. Locate the filter to be removed. Push the filter out of the wheel using the eraser end of a pencil or other soft blunt object. Remove all filter components from that position in the wheel.

8. Locate the neutral density filters, dot screen, and transmittance filters that were included with the replacement filter and drop them first into the cavity. Install the interference filter with the mirror side down. Place (2) very small dabs of silicone adhesive on either side of the filter to prevent it from working loose. Avoid smearing silicone adhesive on the filter surface. Allow the adhesive to cure overnight.

9. Install the filter wheel taking care not to pinch washers under the shaft. Reassemble the shaft and washers as disassembled. Tighten the shaft securely. The filter wheel should spin freely.

10. Install the filter wheel belt. Be sure that the belt is centered on the filter wheel and is not twisted.

11. Install the photometer PCB taking care to center the board around the shaft.

12. Replace the photometer cover, taking care to position the cable in the slot of the cover. Do not pinch the cable under the cover. Tighten cover screws only until snug. Do not over tighten the photometer cover screws!

13. Install the photometer subassembly to the chassis by replacing the (3) #6 self tap screws through the chassis base. Line up photometer with locating marks made in step 2. Connect the (2) cables removed in step 1.

14. Attach the power cord and connect the instrument to the mains supply. Set the power switch to ON (1). Select test #186. The displayed numbers represent the voltages of the installed filters. All voltages should be between 2 and 11 volts.

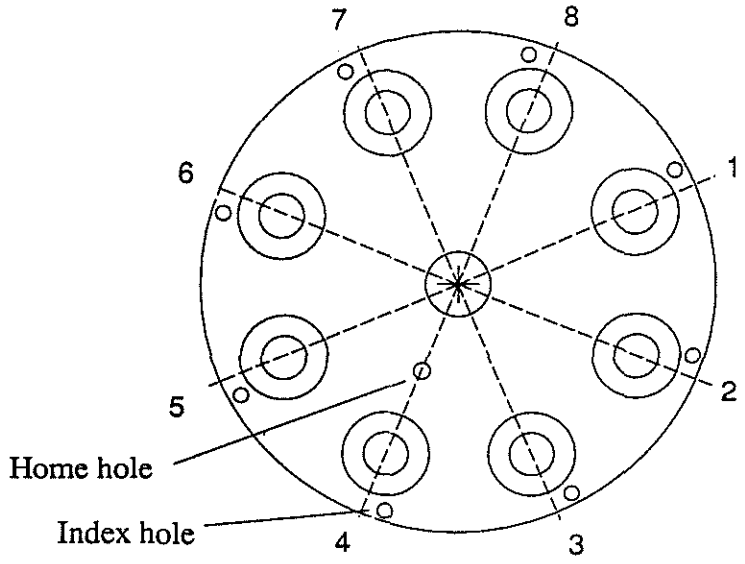
Filter wheel position

Filter configuration

POS	WAVELENGTH	LOT#	DATE
1	340	3YGF 58.8%	5/23/94
2	BLOCKED		5/23/94
3	BLOCKED		5/23/94
4	630/90D/115/170	4GDB 80.6%	5/23/94
5	580/90D/115/170	3ZCJ 65%	5/23/94
6	545/215	3WEF 74.4%	5/23/94
7	505/215/15D	4FLR 67.6%	5/23/94
8	405/115/90D	4HDL 83%	5/23/94

Interference filter lot number & transmittance

Production date



Filter wheel positions

Figure 12. Filter Label and Filter Wheel Positions

Filter Label

The filter label located on the photometer cover describes the specific filter wheel configuration for your particular instrument. Refer to Figure 12.

Filter wheel position (POS) is the physical placement of the filter on the wheel. The filter wheel position numbers are shown in the drawing.

Each filter position may have several filter elements installed. Filter configuration (WAVELENGTH column) describes the various screens and filters in that position . Each element is separated by a slash (/). The first 3 digit value in this column is always the wavelength of the interference filter, in nanometers. The other values indicate either dot screens, neutral density filters, or transmittance filters. A "D" indicates a dot screen and the first two digits are the percent transmittance. For example ,"90D" indicates a 90% dot screen. A 3 digit value (other than the first value in the line) indicates a transmittance filter. The first digit is the quantity; the last two digits are the percent transmittance. For example, "115" indicates (1) 15% transmittance filter. A 2 digit value separated by a decimal point indicates a neutral density filter. The value is the absolute absorbance of the filter. "BLOCKED" indicates an opaque disk is installed in that position.

Manufacturer lot number (LOT#) is the interference filter manufacturers' production code. The percent transmittance of the interference filter is also specified in this column.

The production date (DATE) is the date the filter wheel was assembled.

Calibration

This instrument relies on software calibration, that is, on calibration data stored in non-volatile RAM. This data is used by the microprocessor to compensate for variations in electronic components and manufacturing. During factory calibration, the calibration data is set and any hardware adjustments are made using precision reference standards. The calibration data is then recorded on a label located on the bottom of the instrument. The factory calibration is very stable and does not drift appreciably over time, making trimpot or other component adjustments unnecessary unless the trimpots are disturbed or calibration-related components replaced.

Recalibration of the instrument, software or otherwise, should not be considered until all possible interfering factors have been ruled out. If field calibration is in fact necessary, it should only be performed with the proper reference materials and instruments. In any case, software calibration should be attempted before any trimpot or component replacements or adjustments are considered.

The temperature calibration data is stored as offsets which the instrument adds to the sensed temperatures. Separate offsets are maintained for the incubation block and the read well. The absorbance calibration data is stored as a scaling factor, which is the ratio of a known reference absorbance to the instrument's reported absorbance. The calibration data may be printed at any time by selecting test #213. This prints the serial number of the instrument, the date of last calibration, and the stored calibration data for the absorbance, block temperature, and cell temperature.

The calibration data is stored with a check sum that is recalculated and compared each time a mode is selected. Failure to recover the calibration data properly (checksum failure) will be indicated on the display and the internal printer:

```
Do Temp Test 210!
Do Abs Test 212!
```

The instrument annunciates this condition with multiple beeps. The temperature offsets for both the incubation block and the read well are then set to 0.0 and the absorbance scaling factor is set to 1.000. In this condition, the maximum temperature error is +/-1.5 °C and the maximum absorbance error is +/-10%. The calibration data can be restored as described in "Restore calibration".

The hardware calibration of the instrument in time is based on a 2 MHz ceramic resonator RES1. Calibration in temperature is based on C24, a 0.068µf polystyrene capacitor, trimpots TP4 and TP5, and time. Calibration of absorbance is based on C16, a 0.1µf polystyrene capacitor, trimpots TP2 and TP3, and time.

Calibration and Absorbance Linearity

Each instrument is calibrated during manufacturing using standards that are traceable to the National Institute for Standards and Testing (NIST), and is tested to verify its linearity to 2A. This preset calibration is very stable. Absolute calibration can be verified with the use of NIST filters, or by periodic comparison to a reference instrument that is known to be calibrated to NIST filters. Calibration may be confirmed using a commercially available calibration check set which can be obtained from your distributor. A periodic verification of instrument linearity is advised. Since most lab test results are based upon standards rather than upon absolute absorbances, the linearity of the instrument is the more critical indicator of instrument performance.

CAUTION

DO NOT ALTER ANY POTENTIOMETER SETTINGS !

Changing these settings will make the factory calibration data invalid.

In the unlikely event the calibration data is lost or corrupted, the absorbance factor is set to 1.000 and the temperature offset adjustments for the block and cell are set to 0.0.

Do not enter values other than those recorded on the calibration label unless absolutely necessary.

Restore Calibration Data

Each unit is electronically calibrated at the factory. The calibration values are entered by the keyboard and stored in non-volatile memory.

```
Do ABS Set Test 212!
Do Temp Set Test 210!
```

If either of these messages are printed or displayed, it indicates that the calibration values have been lost. These messages will be printed each time that you turn on the instrument, select a mode, or recall a test. The instrument will continue to operate, but the calibration must be restored to ensure the accuracy of the instrument.

Follow these steps to restore the electronic calibration:

1. Shut off the instrument. Remove any tubes or cuvettes from the incubation block and read well. Carefully lift up the instrument and locate the Calibration Data label on the underside of the unit. There are three values recorded there: Absorbance, Block Temp, and Cell Temp. Write down these numbers.

2. Set the power switch to ON (1).

3. If the date and time are incorrect, set the correct date and time. Press **TIME** then press **EDIT**. Enter the date and time as prompted.

4. Press **MENU**, type in 210, and press **ENTER**. When the display shows "Block=", enter the number that is recorded under the Block Temp heading on the calibration label. For example "0.3" or "-0.2" and then press **ENTER**.

5. The display will prompt "Cell=". Enter the data from the Cell Temp line of the calibration label.

6. Press **MENU**, type in 212, and press **ENTER**. When the display shows "Abs Factor=" enter the number from the Absorbance line of the calibration label. If the message Adjust Out of Range is displayed, check your values and repeat this step.

7. Press **MENU**, type in 213, and press **ENTER** to get a report of the calibration data. The block and cell temperature adjust will be printed along with the absorbance adjustment. Make sure that these values are the same as those recorded on the calibration label.

Restore Filter Labels

Like the calibration data, the wavelengths for the two optional filters are stored in non-volatile memory. In the event this data is lost or corrupted, the following message will be displayed and printed.

```
Filter Labels 7&8 Clrd!
```

You will need to re-enter the filter labels for two of the filters. Open the instrument and locate the filter label on the side of the photometer cover.

```
Key 7 is xxx
Key 8 is xxx
```

"xxx" is a three-digit wavelength value. Press **MENU**, type in 248, and press **ENTER**. You will be prompted:

```
Change Filter Names
Key 7 =   ??? nm
```

Type in the wavelength for Key 7 that is printed on the label and press **ENTER**.
Repeat for Key 8. Press **CLEAR** twice to return to the main prompt.

Temperature Calibration

Materials and equipment:

- 12 mm borosilicate tube
- Reference thermistor probe
  YSI Inc. #44108 or equivalent.
  30K @ 25°C,± 0.2° interchangeability
- Humalyzer 2000 Temperature Calibration Fixture
- Digital ohmmeter (DMM), 0.5% or better accuracy.

1. Ensure that the flowcell is active. Press CELL. Press YES to activate the flowcell. Press CLEAR twice to revert to the temperature display.

2. Place a 12 mm borosilicate test tube filled with 1 ml of water into the incubation block. Use a station near the center of the block. Suspend the reference thermistor probe in the approximate center of the tube.

3. Remove the flowcell and install the Temperature Calibration Fixture into the read well.

4. Allow 15 minutes for equilibration.

5. Set the DMM to read 20K. Read the resistance of the thermistor and the fixture. If the resistance is between **17724** Ω and **18712** Ω, no adjustments are needed. Otherwise, continue to the next step.

6. Calculate the temperature offsets using the following formula:

$$T = \frac{R - 18210}{C}$$

Where:

R is the measured resistance.
C is equal to 750 if the measured resistance is greater than 18210.
C is equal to 720 if the measured resistance is less than 18210.

7. Select test #210. The display shows:

```
Block adjust=
```

Type the offset calculated above for the block and press ENTER.

8. The display shows:

```
Cell adjust=
```

Type the offset calculated for the cell and press ENTER. The maximum allowed adjustment is +/-1.8°C . Entering values that exceed this net number will produce an out of range message.

9. Repeat steps 4 through 8 until the temperature is 37°C ± 0.3.

10. Select test #213 to see the current net adjustments. Record the new values on the calibration label located on the bottom of the instrument.

Absorbance Calibration

Materials and equipment:

- 12 mm borosilicate tube
- Reference spectrophotometer
- Reference material which peaks at one of the instrument's wavelengths.
- Precise 1:2 serial dilution of the reference material.

1. Ensure that the flowcell is active. Press **CELL**. Press **YES** to activate the flowcell. Press **CLEAR** twice to revert to the temperature display.

2. Place a 12 mm borosilicate test tube filled with 1 ml of water into the read well.

3. Select test #186 and confirm that all of the filter voltages are between 2.00 and 10.00 volts.

4. Determine the absorbance of both the 1:1 reference material and the 1:2 dilution on a reference spectrophotometer. The 1:2 dilution should be in the range of .8 to 1.2 absorbance. The 1:1 material should be in the range of 1.6 to 2.4 absorbance.

5. Press ABS to place the instrument into the absorbance mode. Select the required wavelengths. Blank on the same diluent material used to prepare the concentrations.

6. Read the 1:2 dilution. Divide the absorbance as read on the reference spectrophotometer by the reported absorbance value.

7. Exit the absorbance mode and select test #212. At the prompt "Absorbance factor= x.xxx?", enter the ratio calculated. When this factor is entered the instrument will display a net factor (the new calibration data).

8. Press **CLEAR** twice and restart the absorbance mode. Blank as before on the diluent. The 1:2 dilution absorbance should now agree with the reference to within +/-.005 absorbance.

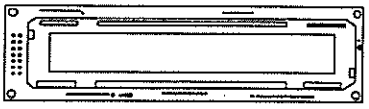
9. Read the 1:1 concentration. It should agree within +/-2 % of the reference. If necessary, carefully adjust trimpot TP3 to achieve this agreement. Re-blank and reconfirm the values.

10. Select test #213 to print the new calibration data. Enter these values on the calibration data label on the bottom of the instrument.

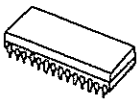
Specifications

Specification Date	31 May, 1994
Model Name	Humalyzer 2000, Cat. No. 18-300
Spectrophotometer Type	Filter photometer
Optical Configuration	Single beam with continuously rotating filter wheel Monochromatic or bichromatic reading 8 filter positions
Usable Spectral Range	330 to 700 nm
System Procedures	Open and by stored menu
Calculating Modes	Absorbance Single Standard Differential samples Factor Mode Differential samples Multi Standard Mode (7 standards) Multi Standard % Abs (7 standards) Kinetic Mode By Factor or by Standard Fixed Time Kinetic By Factor or by Standard
Channels	35 fixed, 24 open
Source of Radiation	Tungsten Halogen, 10 Watt, with automatic lamp saver
Selection of Wavelength	By filter
Filter	
Type	4-cavity interference, long-life ion beam-assisted deposition
Wavelength Accuracy	+/- 3 nm
Filter Location	After sample (heat filter before sample)
Filter Selection	Automatic by software or via keyboard
Wavelengths	340, 405, 505, 545, 580, 630 nm supplied standard other/additional filters optional
Half Bandwidth	< 10 nm
1/100 Bandwidth	14 nm at 340 nm
False Radiant Energy Ratio	< 0.001 at 340 and 405 nm
Cuvette	
Type	Flow-through
Material	316 stainless, borosilicate windows
Geometry	Cylindrical, 2.3 mm dia x 5 mm +/- 0.05 mm
Illuminated Volume	21 µL
Minimum Read Volume	250 µL
Aspiration/Purge	Vacuum pump at 18 cm of Hg
Valve	Silicone pinch type

Other Vessels	12 mm test tubes 1 cm square cuvettes
Cuvette Holder	Thermostatically controlled compartment at 37° C
Detector	Gallium-Arsenide-Phosphide photodiode
Signal Processing and Display	
Display Type	2 line x 24 character super twist LCD
Scale of Display	
Absorbance	-0.5 to 3.5 (flow-through mode) -0.5 to 2.5 (tube or 1 cm cuvette)
Concentration	Maximum 999,999
Kinetic Results	Abs/min with resolution of 0.0002 A/min
Zero Compensation	Automatic
Range	-0.5 to 2.0 absorbance
Signal Outputs	
Parallel	Centronics/IBM-PC compatible
Serial	RS-232 at 2400 baud, 8 data, 1 stop, no parity
Spectrophotometric Inaccuracy	
Flow-through	< 0.5 % at 1 absorbance, 340/630 nm NADH solution < 1% at 2 absorbance, 340/630 nm NADH solution < 3 % at 3 absorbance , 340/630 nm NADH solution < 0.5 % at 1 absorbance, 405/630 nm PNP solution < 1 % at 2 absorbance, 405/630 nm PNP solution < 3 % at 3 absorbance, 405/630 nm PNP solution
Stability	Better than 0.003 A/hr monochromatic after warm-up Better than 0.001 A/hr bichromatic after warm-up
Warm-up Time	90 seconds photometric 15 minutes for temperature compartment
Electronics	Z80 microprocessor 8 K bytes Static RAM (SRAM) 8 K bytes non-volatile RAM (NVRAM)
Power Supply	115/230 VAC, 50/60 Hz, +/- 10%, 60 VA
Dimensions and Weight	35 x 40 x 15 cm, 10 Kg
Space Requirements	10 cm clearance on all sides



Item 8.
18340/25



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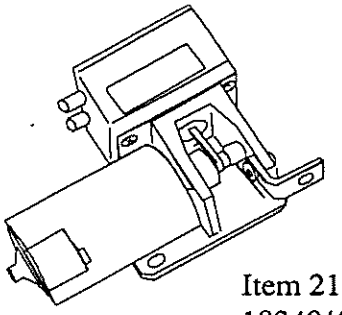
18340/15



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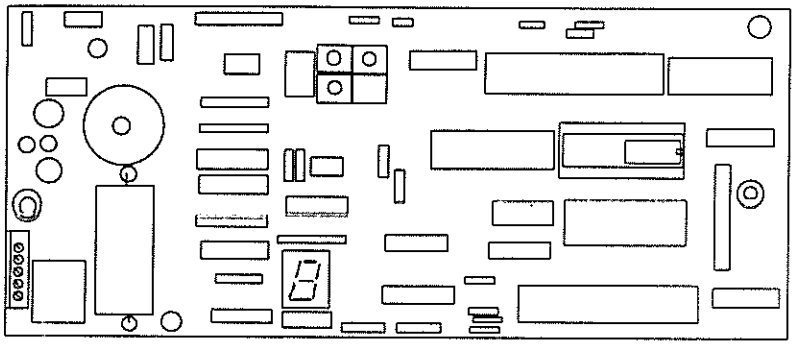

Item 6.
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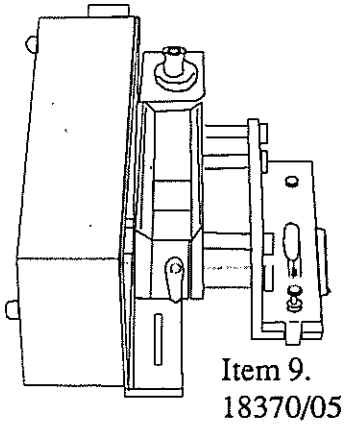

Item 9.
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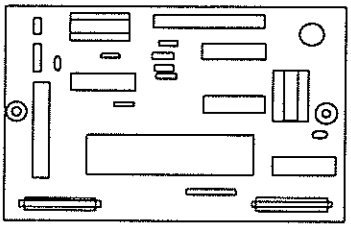

Item 7.
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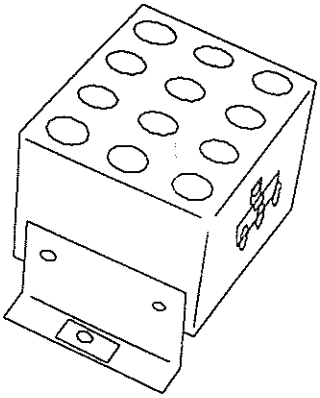
Item 13.
18360/05



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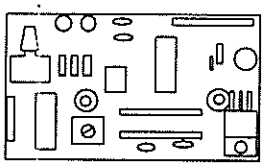
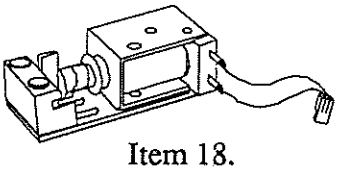
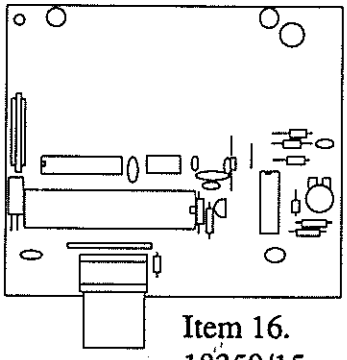
18330/05
18330/10
18330/15
18330/20
18330/25
18330/30



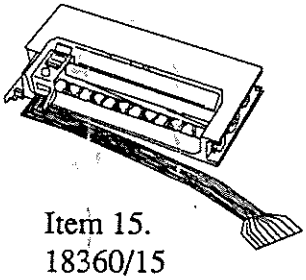
Item 17.
18350/20



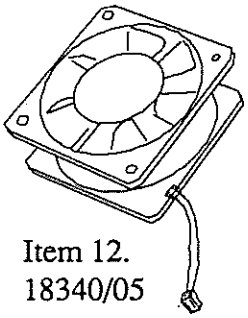
Item 18.
18360/10



Item 16.
18350/15



Item 15.
18360/15



Item 12.
18340/05

Figure 13. Replacement Parts, 1 of 3

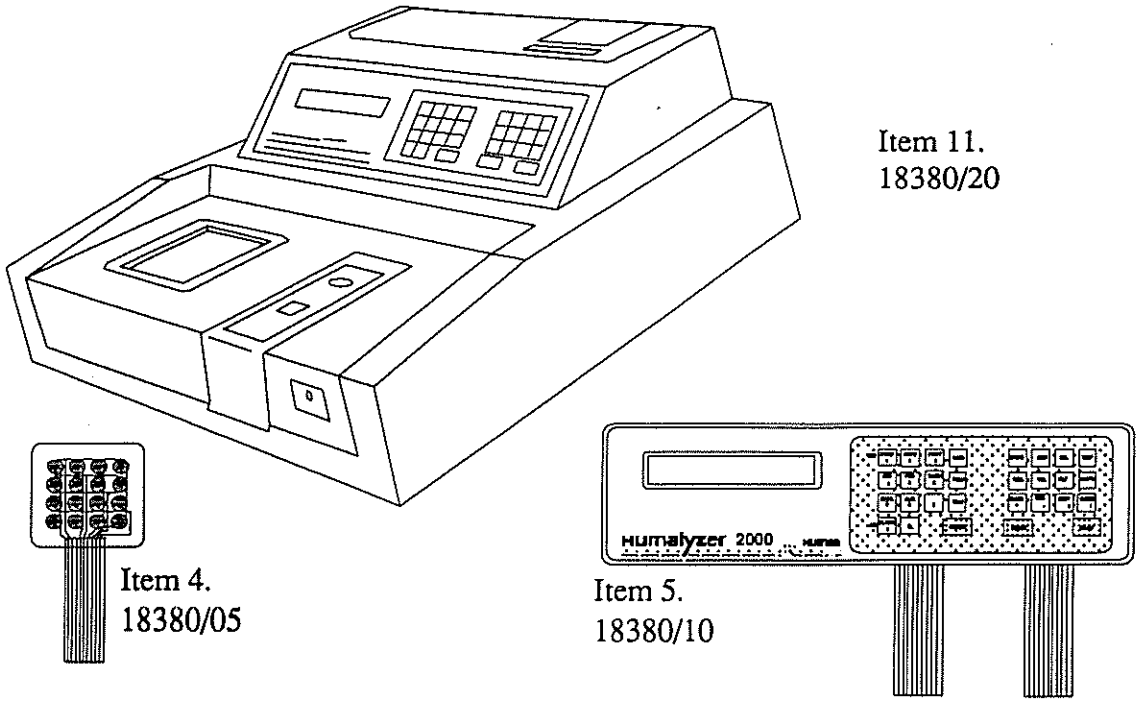


Figure 14. Replacement Parts, 2 of 3

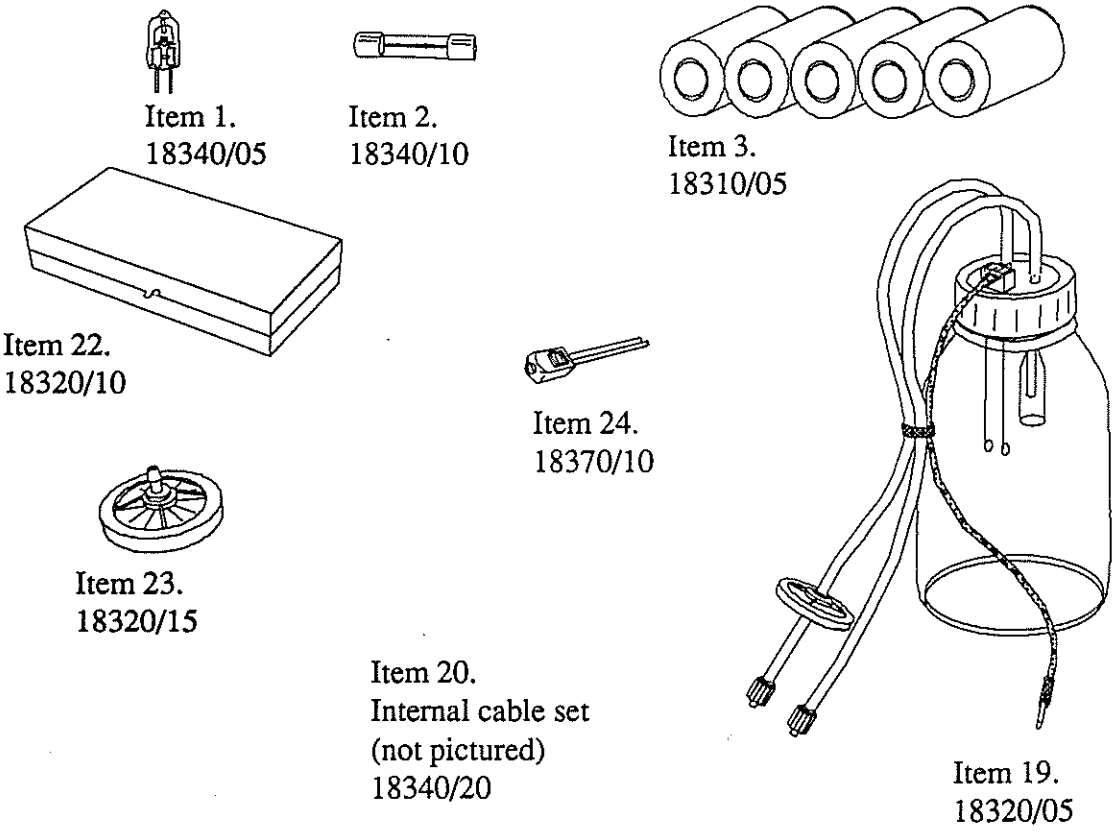


Figure 15, Replacement Parts, 3 of 3

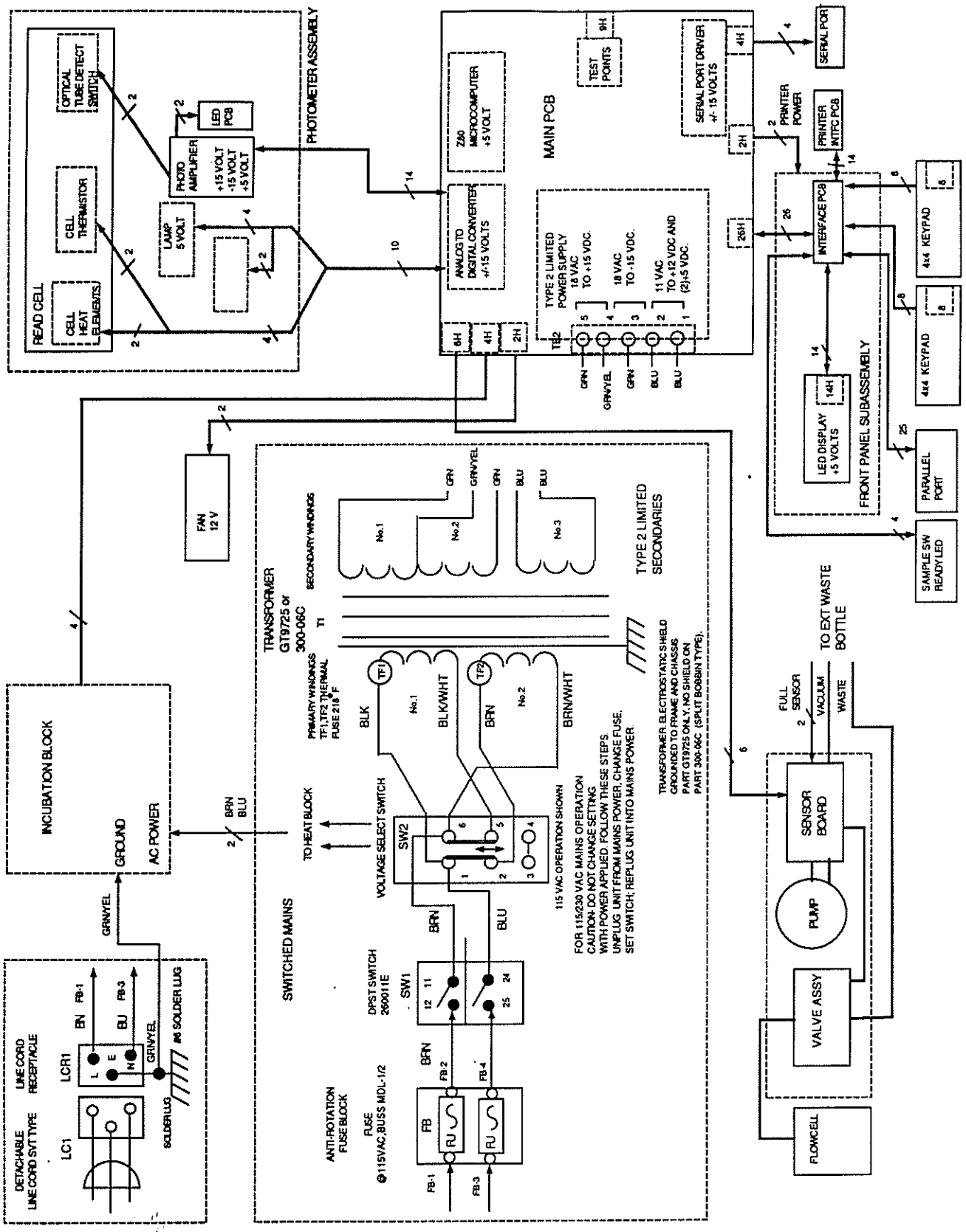
Replacement Parts

See Figures 13-15 for illustrations.

Item	Description	Cat #
1.	Lamp	18340/05
2.	Fuse	18340/10
3.	Printer paper	18310/05
4.	Keypad (domed)	18380/05
5.	Overlay with keypads	18380/10
6.	Main PCB	18350/05
7.	Interface PCB	18350/10
8.	Display (LCD)	18340/25
9.	Photometer assembly	18370/05
10.	Incubation block assembly	18340/35
11.	Cover assembly	18380/20
12.	Fan	18340/30
13.	Filter wheel belt	18380/05
14.	NV RAM (battery-backed)	18340/15
15.	Printer mechanism	18360/15
16.	Printer interface PCB	18350/15
17.	Pump control PCB	18350/20
18.	Valve assembly	18360/10
19.	Waste bottle assembly, 500 ml	18320/05
20.	Internal cable set	18340/20
21.	Vacuum pump	18340/40
22.	Tubing kit	18320/10
23.	Exhaust filter	18320/15
24.	Cell insert	18370/10
25.	Replacement filters	
	340 nm	18330/30
	405 nm	18330/05
	505 nm	18330/10
	545 nm	18330/15
	580 nm	18330/20
	630 nm	18330/25
	Special filters	(Specify)

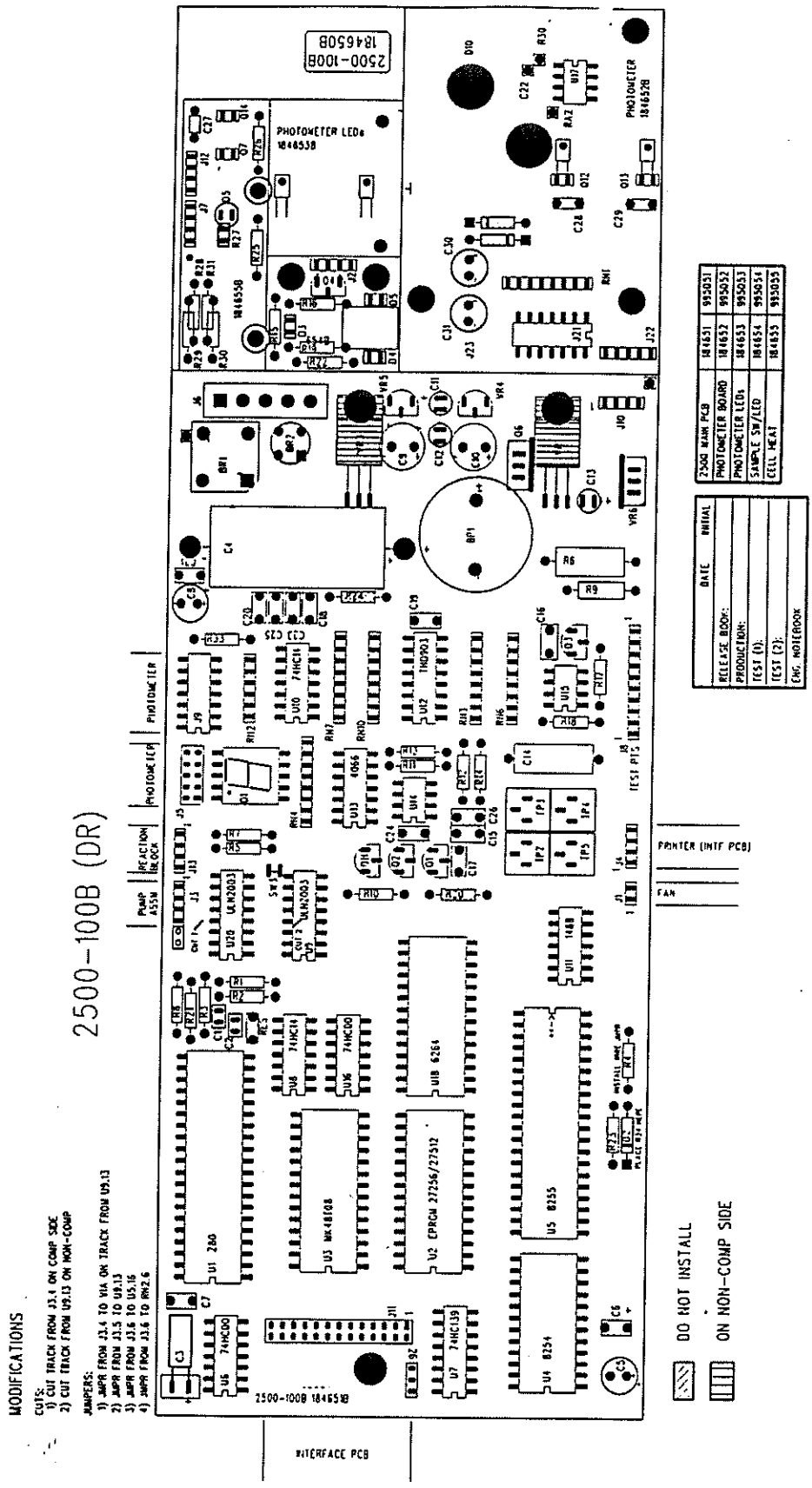
Diagrams

Block Diagram

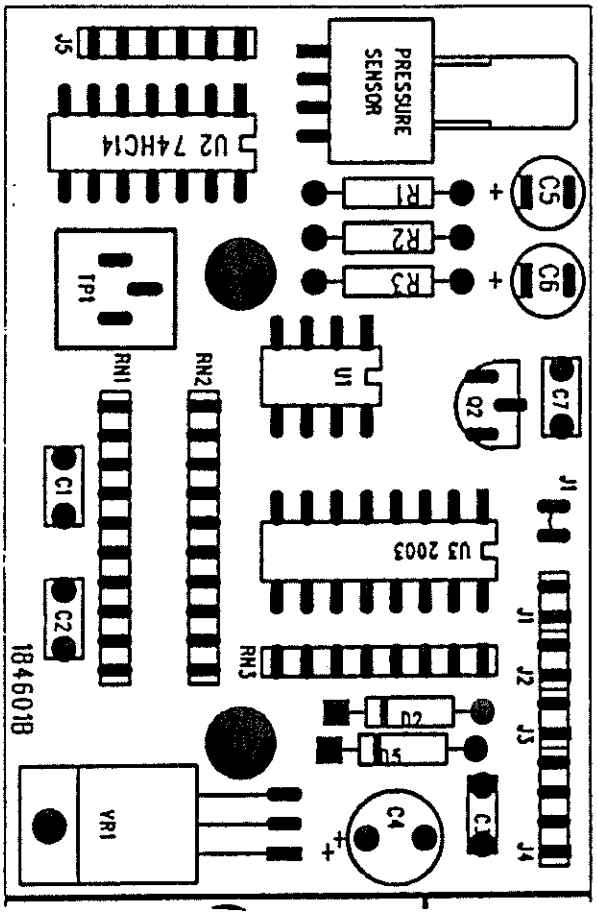


PCB Layouts

Main PCB

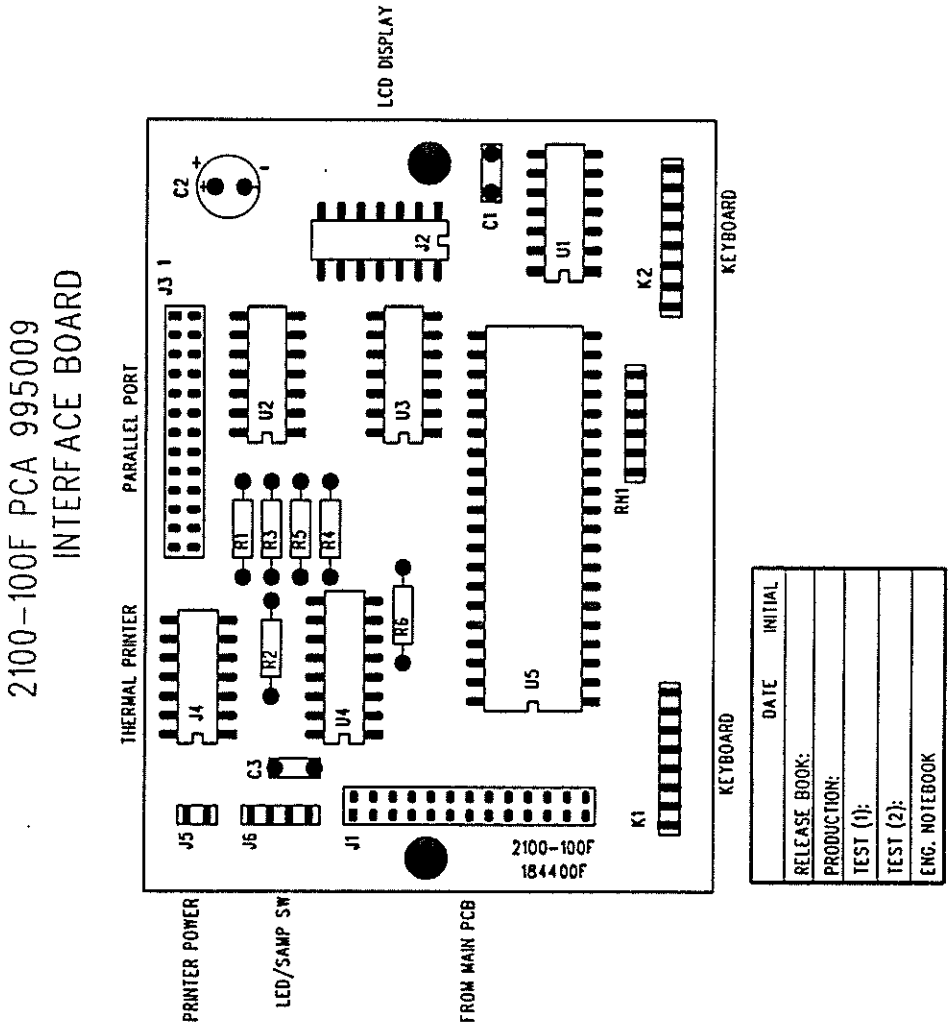


Pump Control PCB

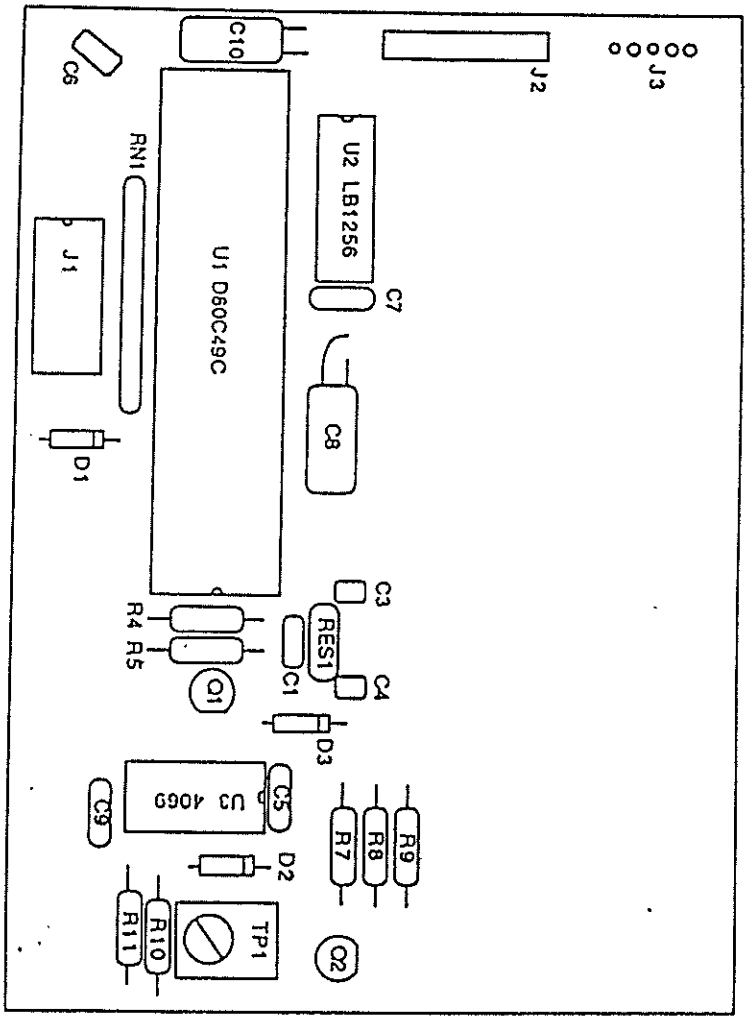


2400-100B

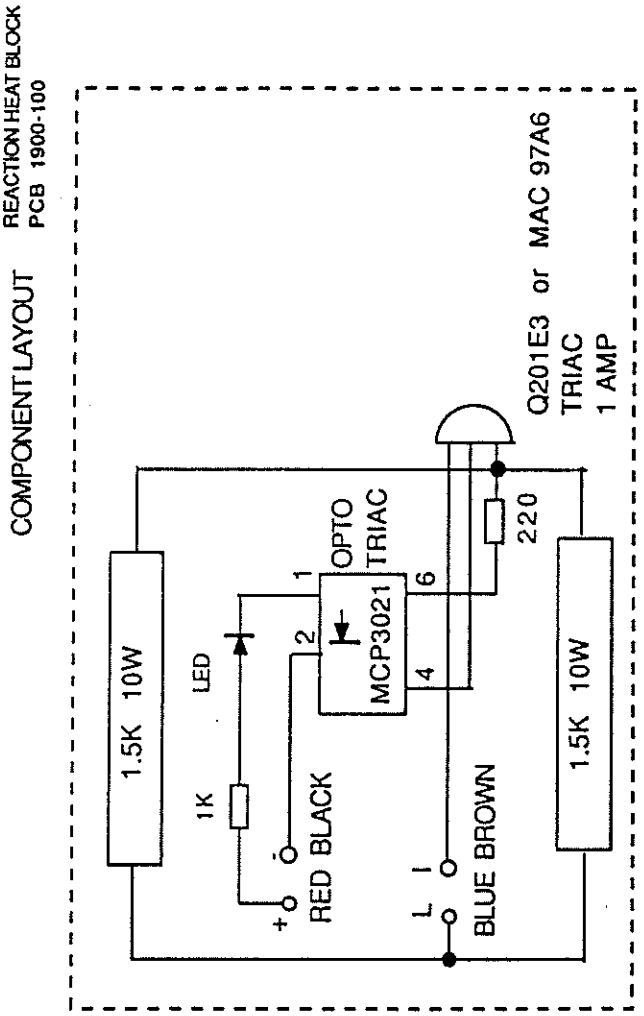
Interface PCB



Printer PCB

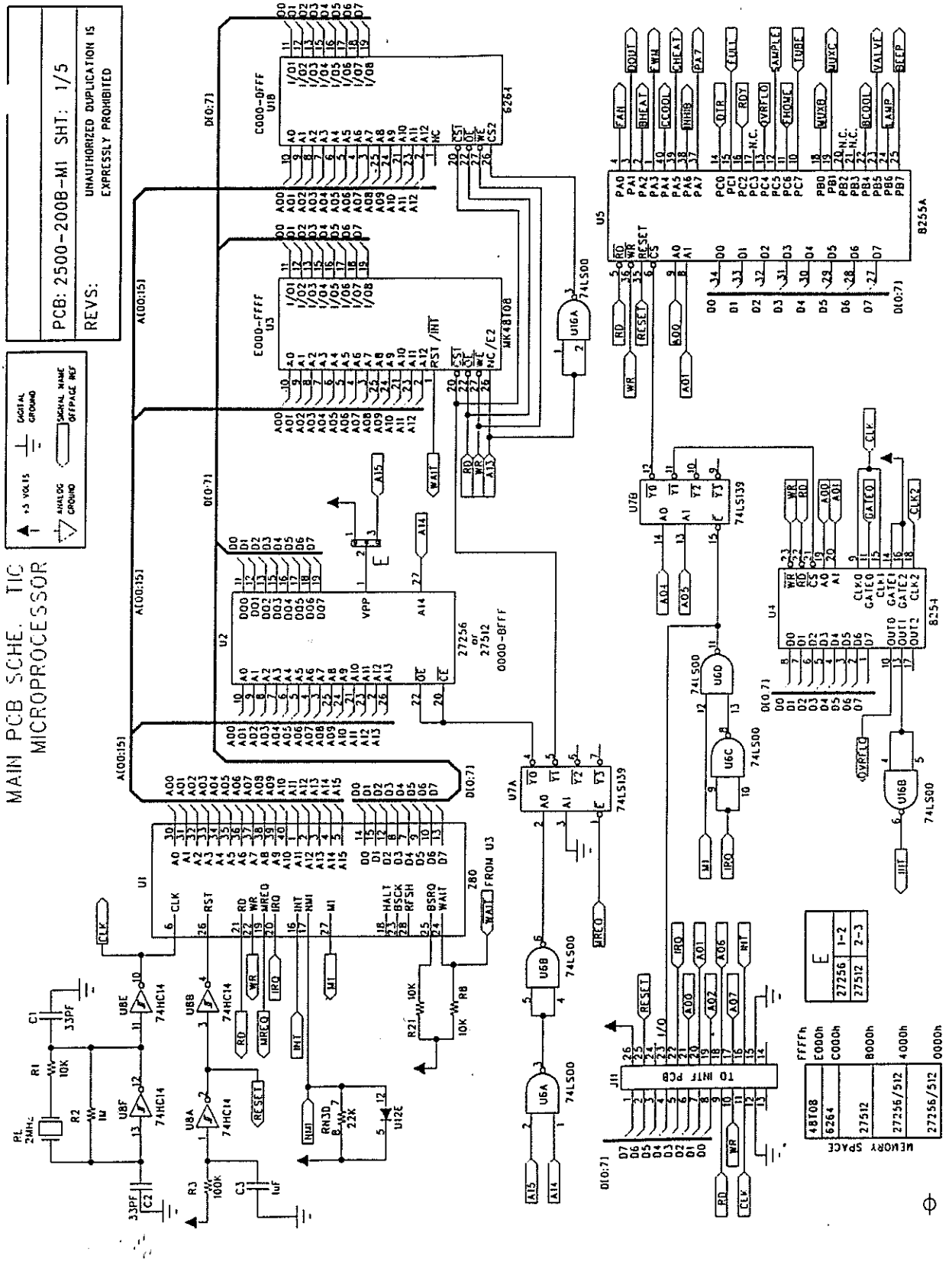

C10
C6
J2
J3
RN1
U2 LB1256
U1 D60C49C
J1
C7
C8
D1
C3
R4 R5
RES1
C1
C4
Q1
D3
U3 4069
C5
C9
R7
R8
R9
D2
R11
R10
TP1
Q2

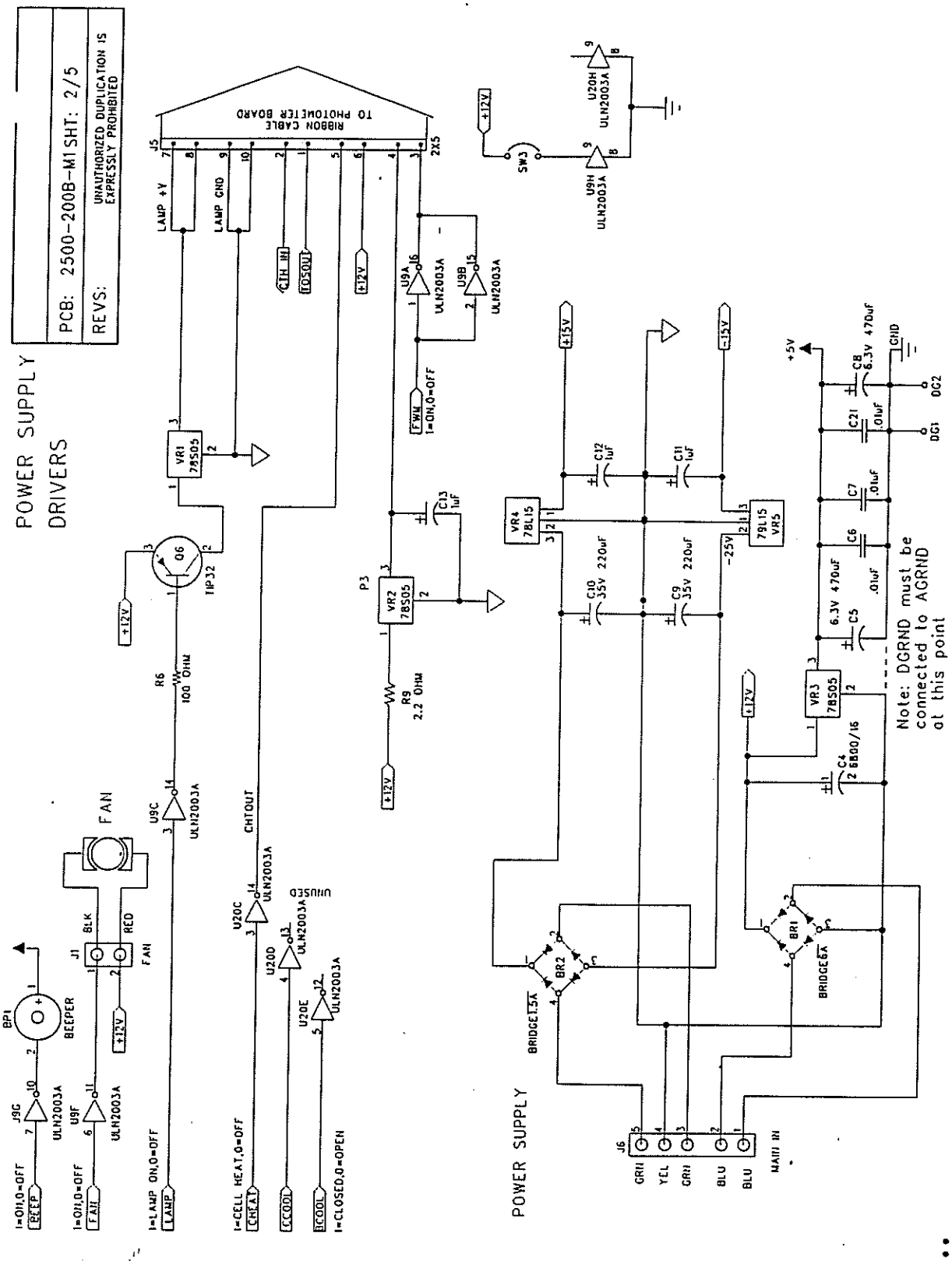
Incubation block PCB

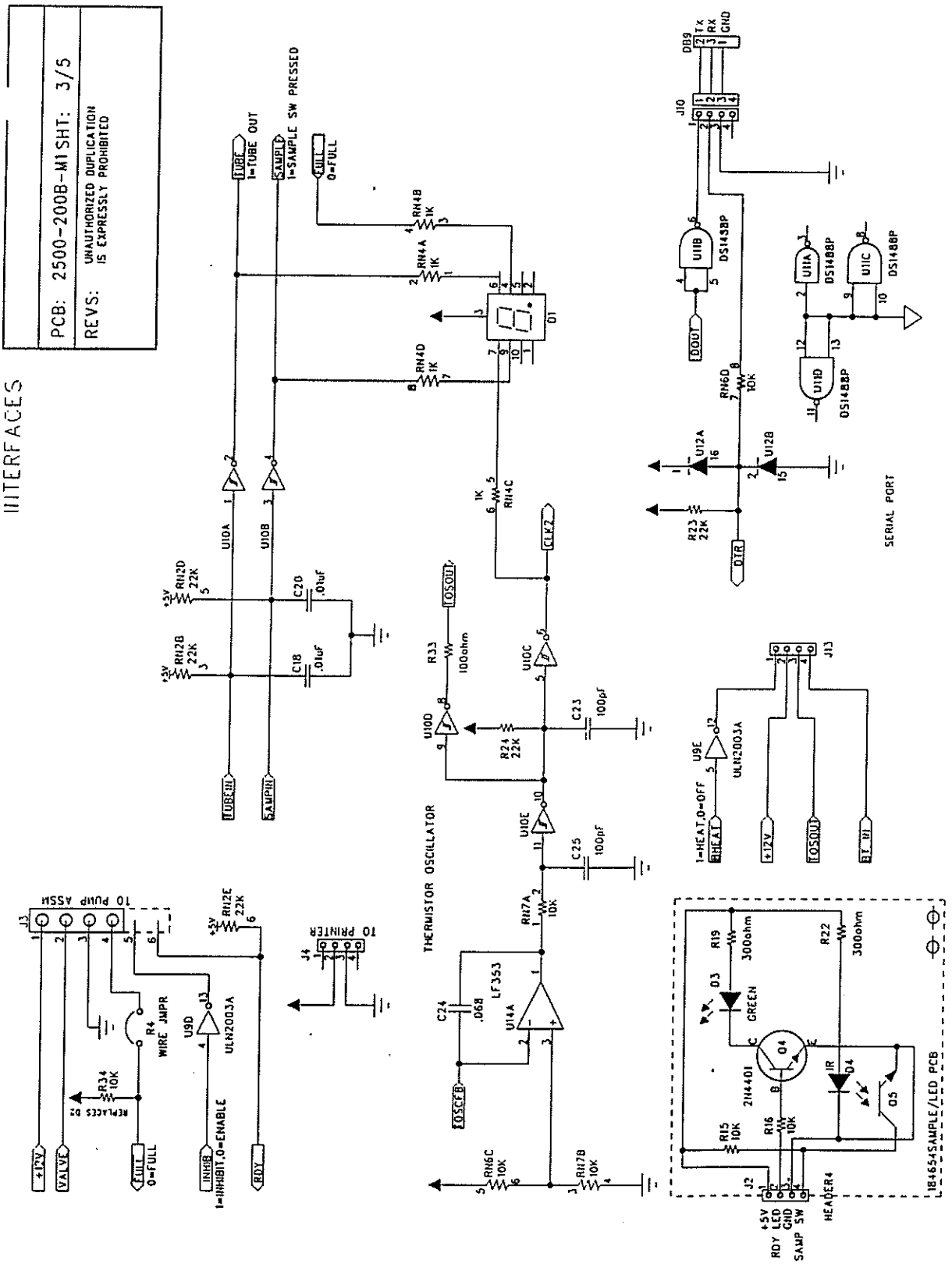


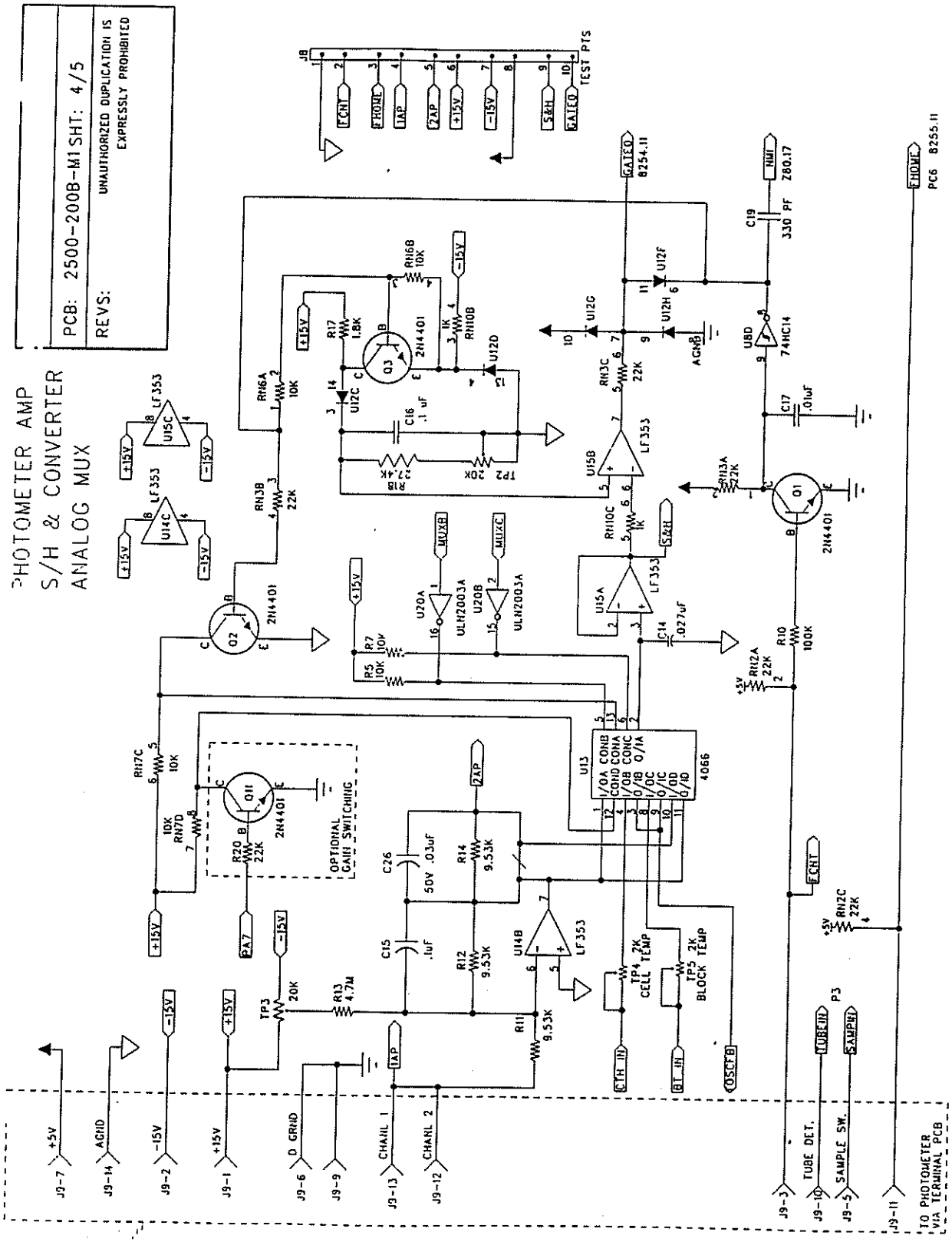
Schematics

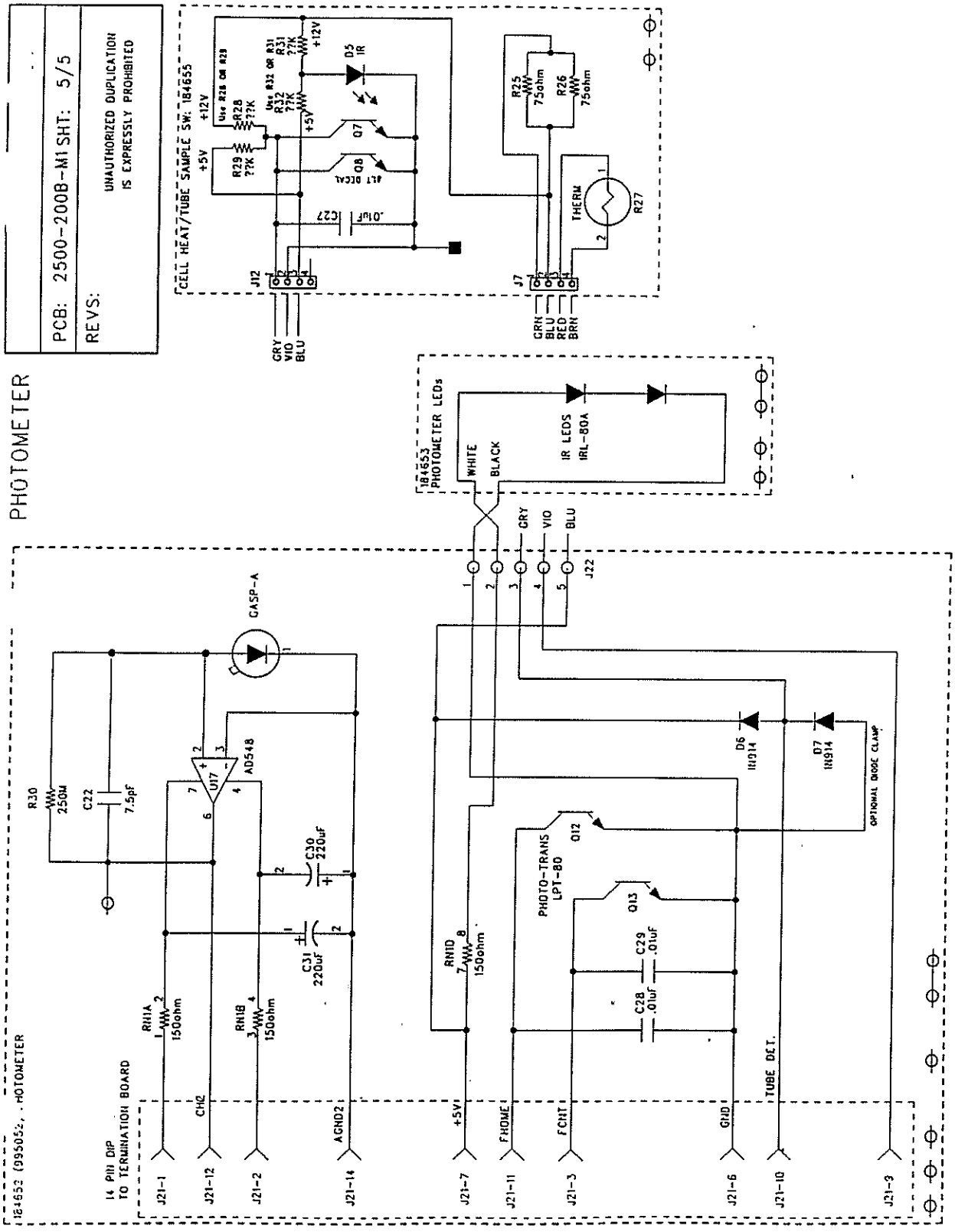
Main PCB



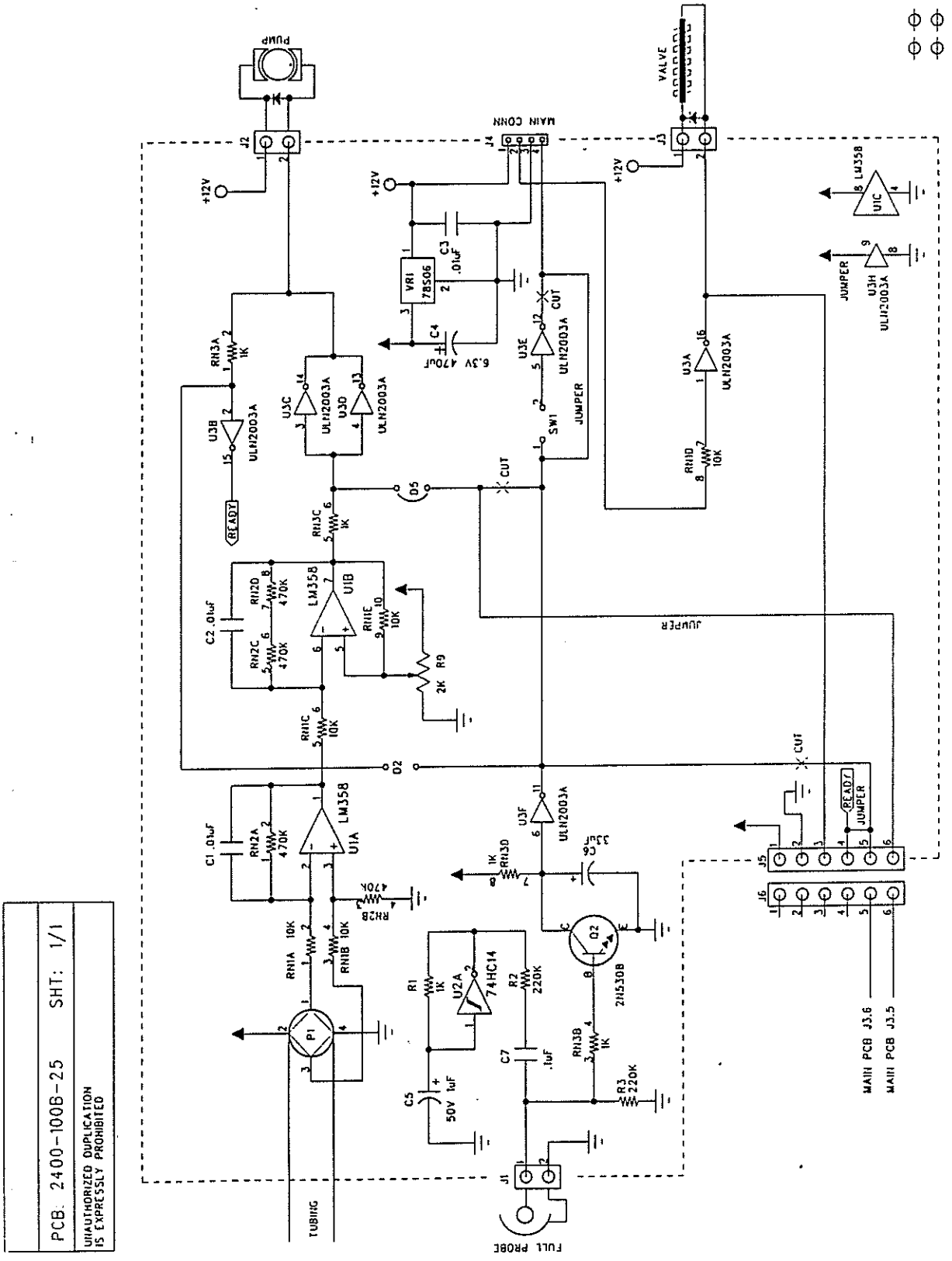

POWER SUPPLY
DRIVERS
PCB: 2500-200B-M1 SHT: 2/5
REVS:
UNAUTHORIZED DUPLICATION IS EXPRESSLY PROHIBITED
RIBBON CABLE TO PHOTOMETER BOARD
J5
2X5
LAMP +V
LAMP GND
CTH IN
EOSOUT
+12V
VR1 78S05
Q6 TIP32
R6 100 OHM
U9C ULN2003A
FAN
J1
BLK
RED
BP1
BEEPER
U9G ULN2003A
U9F ULN2003A
I=ON,0=OFF
BEEP
FAN
I=LAMP ON,0=OFF
LAMP
I=CELL HEAT,0=OFF
CHFAN
CHTOUT
U20C ULN2003A
U20D ULN2003A
U20E ULN2003A
UNUSED
CCOOL
ECOOL
I=CLOSED,0=OPEN
U9A ULN2003A
U9B ULN2003A
FWIN
I=ON,0=OFF
P3
VR2 78S05
C13 1uF
R9 2.2 OHM
SW3
U9H ULN2003A
U20H ULN2003A
+15V
-15V
VR4 78L15
VR5 79L15
C12 1uF
C11 1uF
C10 35V 220uF
C9 35V 220uF
-25V
+5V
VR3 78S05
C8 6.3V 470uF
C21 .01uF
C7 .01uF
C6 .01uF
C5 6.3V 470uF
C4 2 6800/16
DGND
DG1
DG2
Note: DGRND must be connected to AGRND at this point
POWER SUPPLY
BRIDGE1.5A
BR2
BRIDGE6A
BR1
J6
GRN
YEL
GRN
BLU
BLU
MAIN IN


PCB: 2500-200B-M1SHT: 3/5
REVS:
UNAUTHORIZED DUPLICATION IS EXPRESSLY PROHIBITED
INTERFACES
TUBE
1=TUBE OUT
SAMPLE
1=SAMPLE SW PRESSED
FULL
0=FULL
RN4B 1K
RN4A 1K
RN4D 1K
D1
U10A
U10B
RN2D 22K
RN2B 22K
C20 .01uF
C18 .01uF
TUBE HI
SAMP HI
RN4C 1K
CLK2
TOSOUT
R33 100ohm
U10C
U10D
R24 22K
C23 100pF
U10E
C25 100pF
THERMISTOR OSCILLATOR
RN7A 10K
LF353
U14A
C24 .068
TOSCFB
RN6C 10K
RN7B 10K
RN2E 22K
TO PUMP ASSY
J3
R4 WIRE JMPR
REPLACES D2
R34 10K
U9D
ULN2003A
+12V
VALVE
FULL
0=FULL
INHIB
1=INHIBIT,0=ENABLE
RDY
TO PRINTER
J4
DB9
TX
RX
GND
J10
U11B
DS1488P
DOUT
RN6D 10K
U12A
U12B
R23 22K
DTR
U11A
U11C
U11D
SERIAL PORT
U9E
ULN2003A
1=HEAT,0=OFF
HEAT
J13
+12V
TOSOUT
ET HI
D3
GREEN
R19 300ohm
R22 300ohm
Q4
2N4401
IR
D4
Q5
R15 10K
R16 10K
J2
+5V
RDY LED
GND
SAMP SW
HEADER4
18465-4SAMPLE/LED PCB

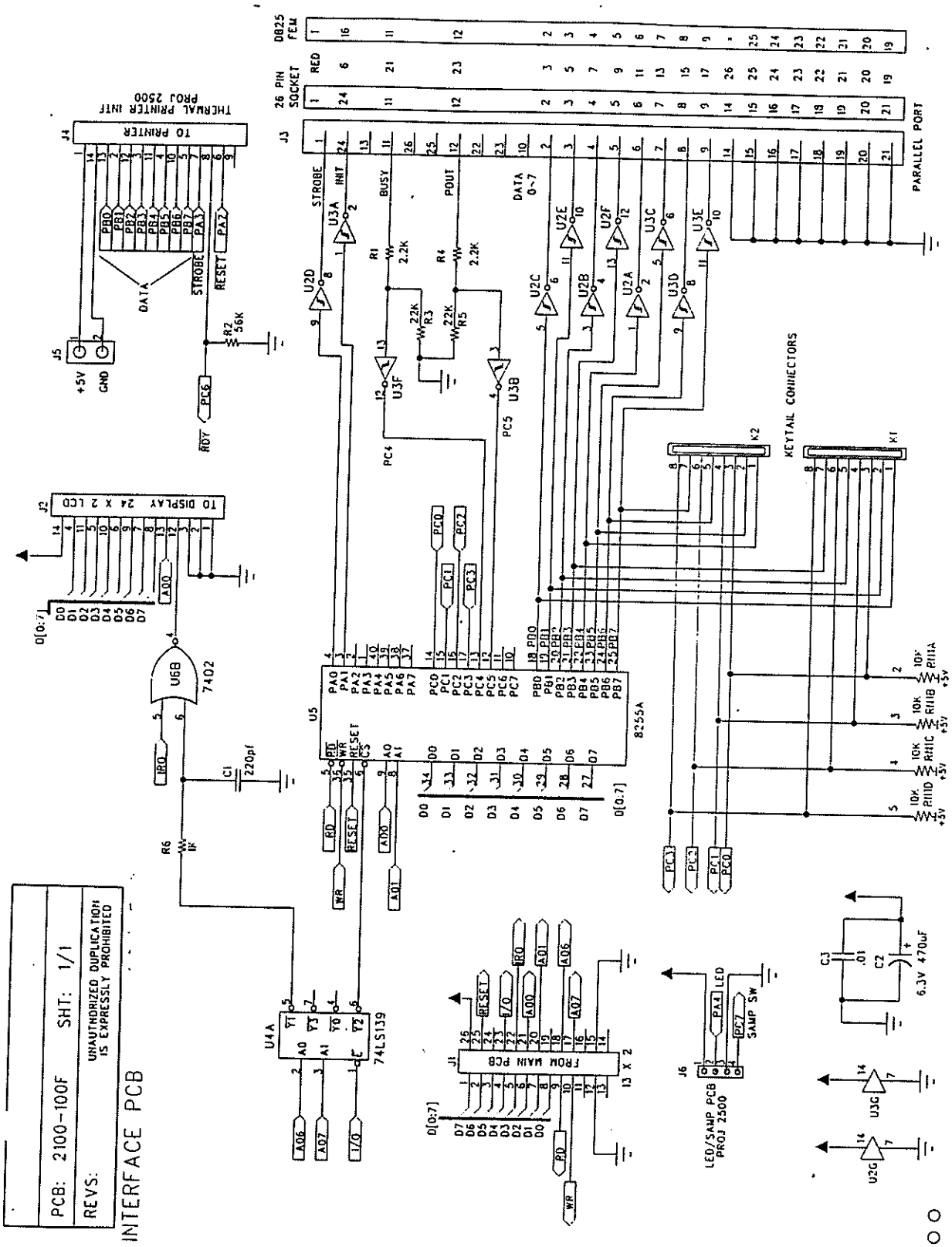

PCB: 2500-200B-M1 SHT: 4/5
REVS:
UNAUTHORIZED DUPLICATION IS EXPRESSLY PROHIBITED
PHOTOMETER AMP
S/H & CONVERTER
ANALOG MUX
TEST PTS
TO PHOTOMETER VIA TERMINAL PCB
TUBE DET.
SAMPLE SW.
CHANL 1
CHANL 2
D GRND
AGND
+5V
-15V
+15V
OPTIONAL GAIN SWITCHING
CELL TEMP
BLOCK TEMP
LF353
4066
74HC14
2N4401
ULN2003A


PCB: 2500-200B-M1 SHT: 5/5
REVS:
UNAUTHORIZED DUPLICATION IS EXPRESSLY PROHIBITED
PHOTOMETER
CELL HEAT/TUBE SAMPLE SW: 184655
184653 PHOTOMETER LEDs
WHITE
BLACK
IR LEDS IRL-80A
GRY
VIO
BLU
J22
GRN
BLU
RED
BRN
J7
J12
D5 IR
Q7
Q8
R25 75ohm
R26 75ohm
THERM
R27
C27 .01UF
R28 ??K
R29 ??K
R30 250M
C22 7.5pF
GASP-A
U17 AD548
C30 220uF
C31 220uF
RN1A 150ohm
RN1B 150ohm
RN1D 150ohm
PHOTO-TRANS LPT-80
Q12
Q13
C28 .01uF
C29 .01uF
D6 1N914
D7 1N914
OPTIONAL DIODE CLAMP
184653 (995052) PHOTOMETER
14 PIN DIP TO TERMINATION BOARD
CH2
AGND2
+5V
FHOME
FCHT
GND
TUBE DET.
J21-1
J21-12
J21-2
J21-14
J21-7
J21-11
J21-3
J21-6
J21-10
J21-9

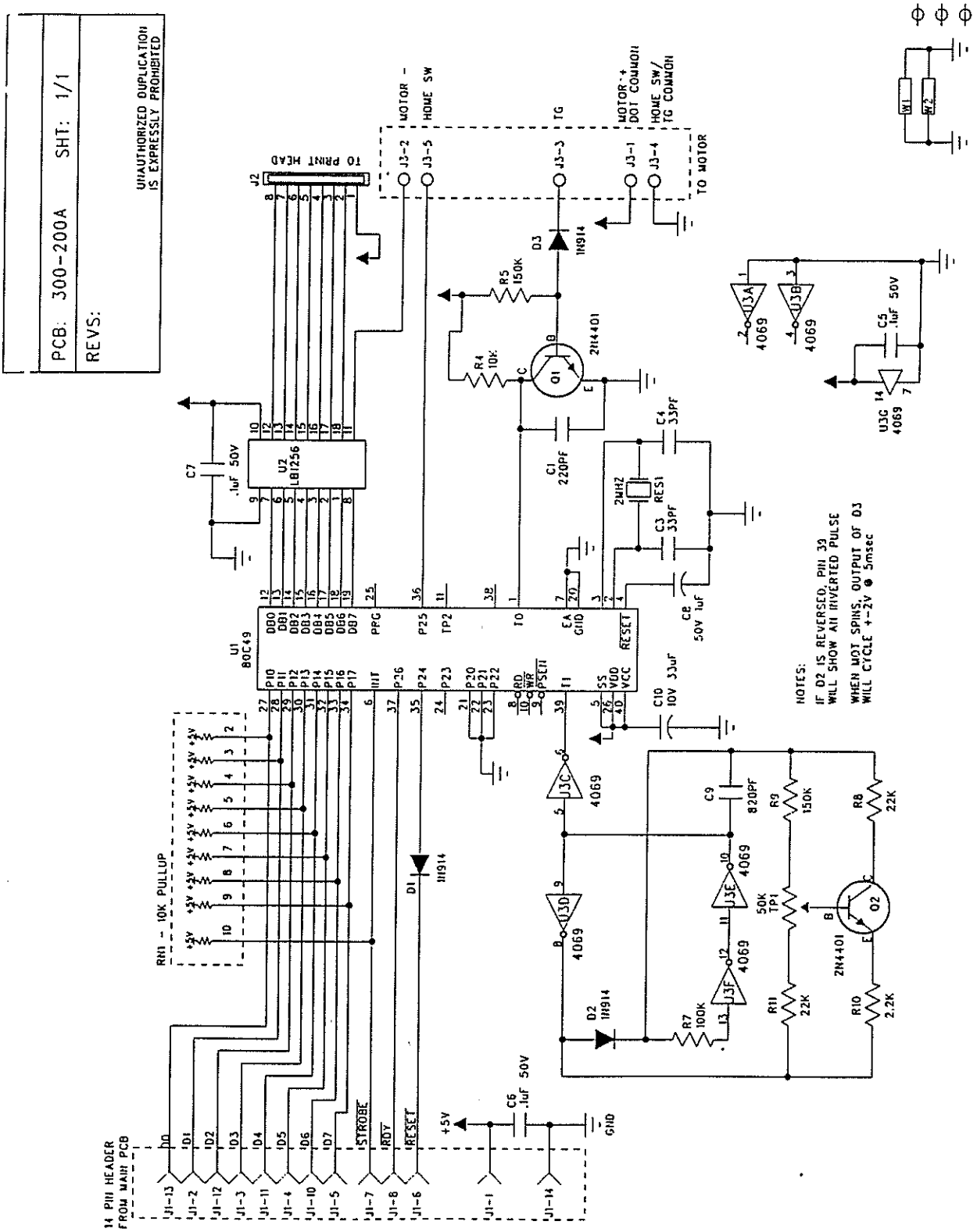
Pump Control PCB



Interface PCB



Printer PCB


PCB: 300-200A SHT: 1/1
REVS:
UNAUTHORIZED DUPLICATION IS EXPRESSLY PROHIBITED
TO PRINT HEAD
MOTOR -
HOME SW
TG
MOTOR +
DOT COMMON
HOME SW/ TG COMMON
TO MOTOR
U1 80C49
U2 LB1256
RN1 - 10K PULLUP
14 PIN HEADER FROM MAIN PCB
STROBE
RDY
RESET
+5V
GND
NOTES:
IF D2 IS REVERSED, PIN 39 WILL SHOW AN INVERTED PULSE
WHEN MOT SPINS, OUTPUT OF D3 WILL CYCLE +-2V @ 5msec

Incubation block PCB